EFFECTS OF AEROBIC TRAINING ON LIPID PROFILE

Dissertation submitted to

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfilment of the

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CERTIFICATE

This dissertation entitled **"Effects of Aerobic Training on Lipid profile"** is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai in partial fulfilment of the regulations for the award of M.D., Degree in physiology in the Examinations to be held during April 2015

This Dissertation is a record of fresh work done by the candidate Dr. M. SATHISH, during the course of the study (2012-2015). This work was carried out by the candidate himself under my supervision.

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DECLARATION

I solemnly declare that the Dissertation titled **"Effects of Aerobic Training on Lipid profile"** is done by me at Thanjavur Medical College, Thanjavur

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Approval No. : 005

This is to certify that The Research Proposal / Project titled

EFFECTS OF TREAD MILL EXERCISE AND CYCLING ON LIPID PROFILE

(EFFECTS OF AEROBIC TRAINING ON LIPID PROFILE)

submitted by Dr. M. SATHISH of

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was approved by the Ethical Committee.

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Dated : 06.12.2013

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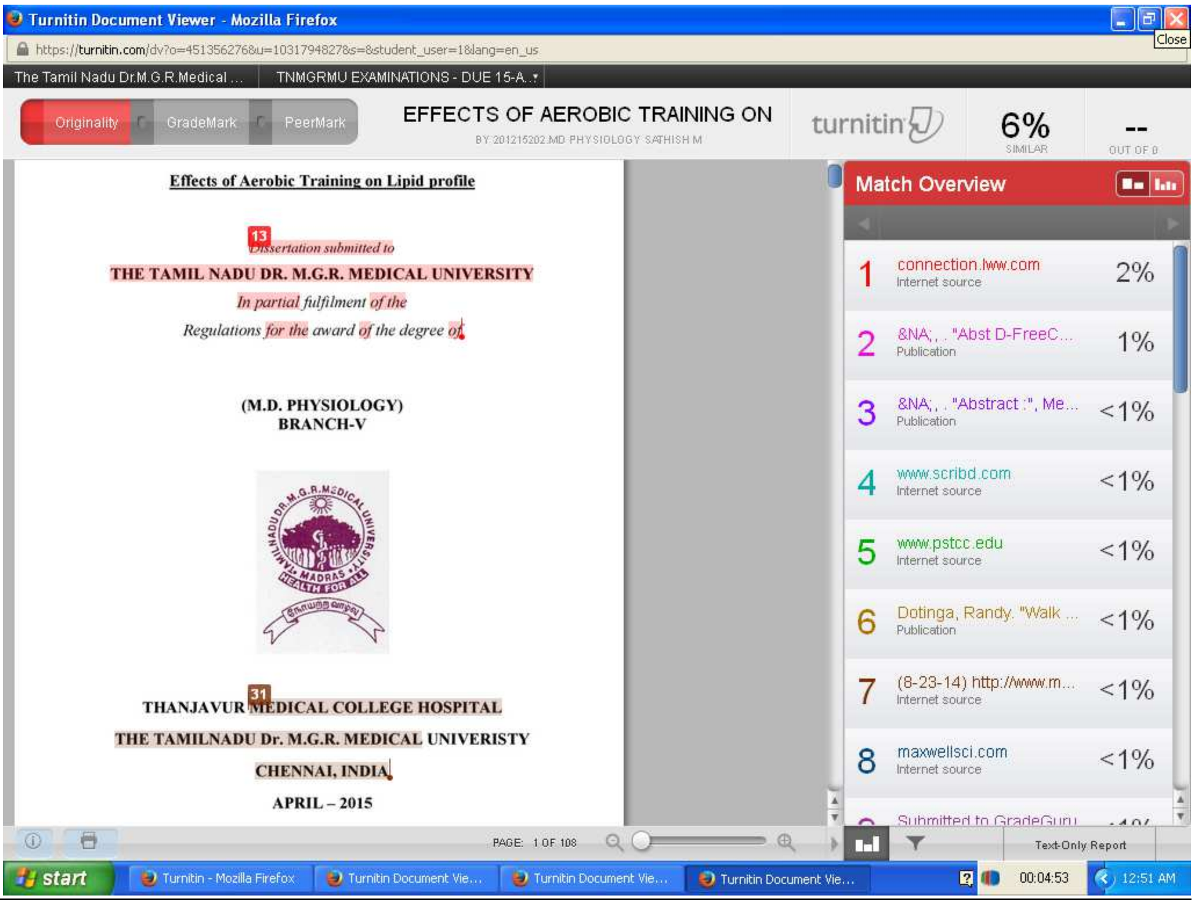
ANTIPLAGIARISM – ORGINALITY REPORT



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CONTENTS

ABSTRACT

Aerobic exercises like walking, running, cycling scores for ordinary persons to improve their physical fitness and health. The aim of this study is to investigate the effects of tread mill exercise and ergometer cycling on lipid profile and also to compare the tread mill and ergometer cycle to identify the better instrument which favours the lipid profile. This study includes 80 subjects, of these 40 subjects were in control group (Group A) and 40 subjects were in aerobic training (study group). The study group is further subdivided into two groups. Group B consists of 20 subjects who underwent treadmill training and Group C consists of 20 subjects who underwent cycling. Inclusion criteria are healthy subjects, without any history of pathological or orthopaedic limitation to activity, and they were not engaged in other exercise programmes. Subjects were recruited from Thanjavur Medical College Hospital and Raja Mirasudhar Hospital, Thanjavur. This study was conducted in the research laboratory, department of physiology, Thanjavur Medical College, Thanjavur, using Treadmill (Cardiotrack 900 XL, Whispermill, Browndove Health care Ltd, Bangalore) 100 steps/ min for 1 hour, and bicycle ergometer (Aerofit India, Hyderabad) 60-70 RPM for 15 minutes. Study subjects underwent aerobic training (moderate exercise) protocol, five days in a week, one hour per day on tread mill for Group B individuals and five days in a week, fifteen minutes per day on the cycle for Group C individuals. Total duration of training was 12 weeks. The full lipid profile was done before the start of the exercise programme for all subjects. Comparison of running versus cycling, and aerobic training group versus sedentary (control) group are of primary significance. After 12 weeks of aerobic exercise training, lipid profile in comparison with the three groups was statistically analysed.

(Key words: Aerobic exercise, Lipid profile, Tread mill, Bicycle Ergometer)

INTRODUCTION

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HISTORY OF EXERCISE: [1]

More than 2000 years ago, Hippocrates first advised that exercise was good for health. In the mid 20th century Prof. Jeremy N Morris revealed vigorous exercise protected against cardiac heart disease. He was the first person who researched on the protective effect for active conductors compared to drivers who were sedentary in London double decker buses. Similarly, when comparing less active government workers with post men the latter seemed to be protected against coronary heart disease[1].

In 1973 Morris et al found a strong association between coronary heart disease occurrence and moderately vigorous and vigorous exercise in the 35 to 64 years age group. Through the advent of computers, more studies were conducted in various ethnic groups, in both males and females, different social group, and different age groups, all of which revealed the effect of exercise on coronary heart disease and prevention of mortality[1]

The term "Aerobics" was first coined by an exercise physiologist Dr. Kenneth H. Cooper, and it was a form of exercise in the 1960's. Cooper first devised exercise for astronauts; he closely monitored oxygen consumption and pulse rate; then he advised similar exercises for the general public. He devised an exercise protocol to prevent CAD, particularly in those with obesity. He wrote a book called "Aerobics" which was very popular then in United States. This created worldwide awareness and led to a huge revolution all over the world on fitness and about people taking care of themselves by modifying their life styles. Scientific evidence based exercise programs were introduced which include walking, cycling, jogging, swimming, dancing, step aerobics [1]. Negative arguments against aerobic was that it was not a complete form of exercise and it might be unsuitable for athletics training and fitness for military services (aerobic exercise protocol originally devised by Dr. Cooper) and others argued, that it might be inefficient in reducing weight of obese patients[1]. Fitness centres all over the world follow different version of aerobics which is a modification of the original aerobics devised by Dr. Cooper. Aerobics made a great impact in the 1960's. In 1968, Jackie Sorenson devised aerobic dance to improvise fitness for cardio vascularity. The first national aerobic championship was held in 1984[1]. In 1996 aerobic sport was recognized as a gymnastic sports discipline. Now all recognize the importance of aerobics and awareness increased regarding aerobics by everybody to exercise at least 30 minutes a day to preserve health and maintain body structure. It is still gaining popularity [1].

Aerobic exercise also protects against atherosclerosis, by maintaining regular high level of physical activity, especially in young and middle aged adult [2]. Presently early rehabilitation program are exclusively based on exercise training. Exercise based cardiac rehabilitation is largely accepted because of reduction of at least 20 percent mortality. This is due to reduction in TC, TGL, systolic blood pressure and raised HDL levels [3]

"Lipid research clinics coronary primary prevention trial" is one of the first randomized trials done to prove the lowering of cholesterol which reduces incidence of coronary heart disease. It was shown in this trial that LDL reduction is directly proportional to the reduction by nearly 20 percent of fatal myocardial infarction and CHD. [4, 5]

ROLE OF LIPIDS IN THE BODY: [6]

1. Energy source and reserve,
2. Protection of vital organs,
3. Thermal insulation,
4. Vitamin (A, D, E, and K) carrier and
5. Hunger suppressor.

ENERGY SOURCE AND RESERVE: [6]

Fat is the ideal cellular fuel as it carries a large quantity of energy per unit weight, providing a ready source of energy. It provides 80 to 90 percent of the energy requirement for a well nourished human under rest [6].

1 gm of pure lipid contains about 9 kcal = 38 kilojoules of energy, which is more than twice than that of carbohydrates or protein; For young individuals 15 percent of body mass of males and 25 percent of that of females consist of fat. The potential energy stored in the fat molecules of the adipose tissue translates to about 108,000 kilocalories [6]

PROTECTION OF VITAL ORGANS: [6]

All vital organs including heart, liver, kidneys, spleen, brain, spinal cord, etc are protected against trauma. Fat present in the subcutaneous plane provides good insulation so that individuals tolerate extreme cold. In contrast, excess body fat hinders temperature regulation during heat stress which is most notable during exercise in severe grade [6]

DYANMICS OF FAT DURING EXERCISE: [6]

During physical activity, intracellular fat and extracellular fat such as free fatty acids, circulating plasma triacylglycerols bound to lipoproteins as VLDL and chylomicrons, supply energy. Energy supply occurs depending on the exercise intensity, duration, and fitness of the individuals. Increased blood flow through adipose tissue with exercise increases the release of free fatty acids for delivery to and use by muscle. The quantity of fat used for moderate exercise is about 3 times more than in a rest condition. The major energy source for moderate exercise is from equal amount of fatty acids and carbohydrate.

EXERCISE TRAINING AND FAT UTILIZATION: [6, 7]

Regular aerobic exercise profoundly improves long chain fatty acid oxidation, especially from triacylglycerols within active muscles. For a total exercise energy expenditure of about 1000 kilo calories, intra muscular triacylglycerol combustion supplied twenty five percent of total energy expenditure before training and this is increased to more than forty percent energy expenditure following training [6]. To increase exercise capacity, aerobic training is considered. The main effect of aerobic training is to increase VO_2 Max. [7] When VO_2 max is attained quickly at lower percentage of work (in moderate exercise), heart rate and systolic blood pressure are reduced. [6]

FACTORS THAT CAN PRODUCE TRAINING INDUCED CHANGES IN EXERCISE ARE: [6]

1. Improved transport of free fatty acids across the membrane of muscle fibre
2. Facilitated fatty acid mobilization from adipose tissue via increased rate of lipolysis within adipocytes
3. Proliferation of capillaries in trained muscle increases the number and density of the micro vessels for energy substrate delivery
4. Increased fatty acid transport within the muscle
5. Increased number of mitochondria and its size
6. Within specifically trained muscle fibre, increased quantity of enzymes involved in citric acid cycle , beta oxidation and electron transport chain
7. Independence of glycogen reserves conservation, cellular integrity maintenance plays an important role in endurance performance.

VARIOUS KINDS OF LIPIDS AND THEIR SOURCES: [6]

Lipid is derived from the Greek word “lipos” meaning fat.

There are two kinds of lipids (1) Simple lipids (2) Compound lipids

1. SIMPLE LIPIDS OR NEUTRAL FATS: (6)

- Triacylglycerol (TAG): This is neutral fat because the pH of the cell has no electrically charged groups. The storage form of fat in adipocytes, hydrolysis of TAG by lipase forms saturated and unsaturated fatty acid [(if 1 double bond - monounsaturated fatty acid (MUFA); 2 or more double bonds - polyunsaturated fatty acid (PUFA)]
- TAG break down (lipolysis) by **hormone sensitive lipase** produces glycerol and fatty acid
- Mobilisation of fatty acid via lipolysis predominates in low to moderate exercise intensity, low calorie dieting or fasting, cold stress, Prolonged exercise that depletes glycogen reserves.

Another form of fat is trans-fatty acid, which is classified as unwanted fat which is available plenty in cookies, cakes, pies, deep fried foods, etc which increase low density lipoprotein cholesterol (LDL) and decrease high density lipoprotein (HDL). Strong evidence proved that trans-fatty acid is also individual risk factor for heart disease, FDA (the Food and Drug Administration) insisted the food processors to mention amount of trans-fat in their product labels. PUFA is available in fish oils contains omega-3 fatty acids [6]

2. COMPOUND LIPIDS: (6, 8)

- TAG combines with phosphorus to form phospholipids,
- Fatty acids bound with carbohydrate and nitrogen forms glycolipids and
- Lipid bound with protein spheres (formed primarily in the liver) forms lipoprotein
- Lipoprotein is the major form of lipid transporter in the blood.
- If lipids do not bind to protein, they float in the blood instead of circulating in the vascular system.

Various form of lipoprotein are classified based on size, density, or carrying cholesterol or TAG, Four types exist on the basis of density,

- 1. Chylomicrons
- 2. High Density Lipoprotein (HDL),
- 3. Very Low Density Lipoprotein (VLDL)
- 4. Low Density lipoprotein (LDL)
  - **Chylomicrons** formed from emulsified lipid droplets from the intestine, enter into the lymphatic system
  - **HDL (good cholesterol)** formed in the liver and small intestine contain largest protein and release lipid and cholesterol
  - **VLDL** these are degraded (by the action of lipoprotein lipase) in the liver to produce LDL, containing high fat content and low protein content, formed in the liver
  - **LDL also** known as **bad cholesterol** which carries 80 percent of cholesterol and has more affinity for the arterial wall. LDL delivers cholesterol to the arterial wall, where it is oxidized to alter their properties, which lead to smooth muscle proliferation and other cellular changes that alter the arterial architecture to narrow down the lumen (unfavourable changes)

INTERACTION BETWEEN DIETARY LIPID AND 'LIPOPROTEINS': [6, 8, 9]

- Cholesterol absorbed in intestine travels through portal circulation and enters the liver
- In the liver, VLDL is formed by combining cholesterol with TAG
- Cholesterol as LDL and TAG as VLDL exit from liver for delivery to peripheral tissues

- LDL delivers cholesterol to arterial tissue, ultimately forms oxidised LDL and deposited on the inside of arteries
- HDL removes excess cholesterol from the cell (reverse cholesterol transport), acts as a scavenger
- HDL releases cholesterol to liver for bile synthesis; ultimately eliminated in the faeces or reabsorbed in the intestine

HDL VS LDL: HEALTH PERSPECTIVE: [6, 9]

- HDL protects against heart disease;
- The amount of LDL (bad cholesterol) and HDL (good cholesterol), their ratio TC / HDL, LDL/HDL, is a good indicator of coronary artery disease risks rather than cholesterol as such.
- Regular moderate and high intensity aerobic exercise and stoppage of smoking can increase HDL level, decrease LDL and alter LDL/HDL ratio favourably [6, 9]

BLOOD LIPID ABNORMALITIES AND CORONARY HEART DISEASE RISK: [6]

- Elevation in serum cholesterol level is directly proportional to CHD;
- High level of total cholesterol and LDL (cholesterol rich) molecule are powerful predictors of increased risk for CAD
- Hyperlipidemia is a crucial component in developing of atherosclerosis.
- It is aggravated by the cigarette smoking, physical inactivity and excess body fat.

CALCULATING CHD RISK FACTORS: [6]

This assess the individual's susceptibility to coronary heart disease (CHD); several quantitative methods are used to estimate the risk of CHD. The Framingham risk score predicts ten year risk of mortality from CHD and non fatal myocardial infarction. This considers age and gender, smoking status, total cholesterol, high density lipoprotein level, blood pressure and diabetes; CHD represents the most common cause of death now. Major risk factors are:

- Blood lipid abnormalities,
- Physical inactivity,
- Obesity,
- Dietary habits,
- Family history, and
- ECG abnormalities during rest and during stress exercise [6]

Serum cholesterol level of 200 mg/dl or lower is desirable, though experts recommend lower values to get the lowest CHD risk. If serum cholesterol exceeds this values, specially in younger individuals where they are prone to get definite CHD in their middle age. So treatment has to started early in these cases [6].

HDL and LDL cholesterol is the most powerful predictor of CHD rather than cholesterol alone. Favourable alteration in HDL cholesterol occurs in sedentary men and women of all ages who regularly undergo moderate to intense aerobic exercise [6]

Sedentary men and women face twice the risk of fatal myocardial infarction rather than their more physically active counterparts.

Nutrition, exercise programmes, and weight control favourably alter CHD risk [6]

American Heart Association (AHA) Recommendations [6]

Variables	Values	Category
Total cholesterol	>240 mg/dl	High blood cholesterol. Twice the risk of heart disease compared to normal individual < 200 mg/dl
	200 to 239 mg/dl	Borderline risk
	< 200 mg/dl	Desirable level, lower risk for heart disease
HDL cholesterol	<40 mg/dl	Low level, major risk for heart disease
	40-59 mg/dl	Higher HDL levels are better
	>60 mg/dl	High HDL cholesterol , considered to be protective against heart disease
LDL cholesterol	>190 mg/dl	Very high,
	160-189 mg/dl	High,
	130-159 mg/dl	Borderline High,
	100-129 mg/dl	Near optimal
	<100 mg/dl	Optimal.
Triacylglycerol	<150 mg/dl	Normal,
	150-199 mg/dl	Borderline High,
	200-499 mg/dl	High,
	>500 mg/dl	Very High,

National Cholesterol Education program (NCEP) Adult Treatment panel (ATP) II [4,10]

SUMMARY OF NCEP ATP II GUIDELINES

Risk Factors:

- HDL level of less than 35 mg/dl,
- History of smoking
- Post menopausal period (with no oestrogen replacement)
- Elevated blood pressure
- Elevated blood sugar levels
- If **HDL is more than 60 mg/dl** it is a **negative risk factor**

Recommendations:

- Always test for lipid profile whenever,
  - (i) HDL cholesterol less than 35 mg/dl,
  - (ii) Cholesterol 200 mg/dl or above
- High emphasis on health education, for strict diet and regular exercise
- For primary prevention, delay the treatment with drug up to 45 years unless there is elevation of LDL Cholesterol.
- Target LDL cholesterol to less than 100 mg/dl in established peripheral, coronary, and carotid disease.

MOST DESIRED SOLUTION "EXERCISE"- INCREASE OUTPUT OF ENERGY [6]

Physically active men and women usually maintain good body composition. An increased level of regular physical activity occurs through either life style modification, improve physical fitness, and body composition. Regular physical exercise ensures less accumulation of central adipose tissue. If an overweight individual shows moderate physical activity or more vigorous exercise (aerobic or resistance) improves cardiovascular fitness. Effectiveness of regular physical activity enhancing muscle sparing effect is also seen, along with muscle mass, muscle strength. Aerobic capacity improves during training. Obese children who did forty minutes aerobic exercise sessions five days a week for four months without diet restriction accumulated less fat in visceral adipose tissue than non-exercising control group [(6)]. Though exercise does not produce weight loss dramatically, exercise mainly targets the excess accumulation of visceral abdominal fat rather than peripheral area fat accumulation. This way exercise protects against insulin resistance (a predisposing factor for type II diabetes). A man does regular physical exercises 5 days a week for 16 weeks by walking 90 min each session; he loses approximately six kilogram of weight. Exercise improves HDL cholesterol level to 15.6 percent [(6)].

Most metabolic improvement occurs with regular physical exercise related to quantity of fat loss and total exercise volume rather than increased cardio respiratory fitness. Ideally, exercise program should include large muscle activity with moderate-to-high caloric expenditure activities like circuit resistance training, walking, cycling, running, stair stepping and swimming.[(6)] “Aerobic exercise” stimulates fat catabolism, favourable blood pressure response, improves cardio respiratory fitness, and elevates resting metabolism. Resistance training is an important adjuvant to aerobic exercise in weight loss programmes; In addition it tones muscle strength. If regularly performed, it reduces the coronary heart diseases risk, favourable modification in lipid profile, improves glycemic control and increases resting metabolic state[(6)]

- The new guidelines now focus on lipoprotein components and less on cholesterol, Triacylglycerol (TAG) [(6)]

- When fasting for 9 to 12 hours, cholesterol level of 200 mg per dl is desirable, the risk is twofold if 230 mg of cholesterol and risk is four fold if level goes up to 300 mg per dl.
- For TAG, 150 to 199 mg per dl is the upper limit with 200 to 499 considered high which requires definite intervention,
- For assessing the risk factors **lipoprotein** is a **powerful predictor** rather than cholesterol alone. Elevated HDL levels relates causally with lower heart disease. TC/HDL and LDL/HDL is more effective in evaluation of the disease process.

FACTORS AFFECTING BLOOD LIPID BEHAVIOUR ARE: [6]

Weight loss, intake of fat in diet, regular aerobic exercise, increase in HDL cholesterol, endurance athletes usually maintain high HDL and those who are engaged in regular physical activity moderate to vigorous aerobic exercise with good intensity, even trained endurance athletes have variable HDL cholesterol level. This suggests that genetic factors play an important role in determining lipid profile. A specific gene which produces endothelial lipase is responsible for decrease in HDL and increasing the risk of CHD. Apart from this, regular physical activity protects from developing of gall stone due to decrease in cholesterol and lipoprotein. Immune response also triggers plague formation inside the arterial wall, mononuclear system from the arterial wall synthesis cytokines. Regular aerobic exercise induces immunity to inhibit these agents so that arterial inflammation is suppressed [6]

EXERCISE PROGRAM: [6]

AHA (American Heart Association) and **ACSM** (American College of Sports Medicine) jointly recommend, exercise programs depending on the individual need. Moderate intensity “Aerobic exercise” with frequency of 30 Minutes for 5 to 7 days a week is associated with improved cardio respiratory fitness. Enhanced daily physical activity even without diet restriction produces weight reduction (particularly reduction in centripedal obesity) [11]. Exercise should include rhythmic big muscle movement, and should take care of cardiovascular fitness. E.g. walking, cycling, skipping rope, cross country ski simulation, jogging, and moderate intensity interval training are well accepted. Ideally it should include optimal frequency, duration, and intensity. [6]

EXERCISE TRAINING PRINCIPLES: [6]

The major objective of a specific task is to improve performance. This is possible by correct frequency, type of training, intensity of exercise, duration, rest interval between activities, and appropriate repetition of activity. To achieve this we require physiological conditioning which applies to both men and women with broad range of age. On different exercise modes and by manipulating frequency of training, intensity, and duration, we can achieve appropriate overload which is required for enhanced training response. Depending on the mode, type of overload adaptation to physiologic functions and metabolic function there are two types of adaptation in exercise

1. Anaerobic (strength-power)
2. Aerobic (Endurance) - is specific to one another with only minimal interchange between these two. Aerobic training depends upon specific muscle group (big muscle group) involved in the training to desired performance to effectively improve aerobic fitness. This is commonly seen in exercise like cycling, swimming, running, upper body exercise. Cardio respiratory stress provides training in specific aerobic activities like cycling, swimming, running. Little difference is seen between these activities. Marked adjustments in local blood flow and metabolism in response to physical activity also contributes to cardio vascular improvement during exercise. Velocity of oxygen transport and consumption of oxygen is maximum after aerobic training. Thus more general improvement in circulatory

system is observed (improvement in cardiac function, ventricular contractility, increased micro circulation, more effective redistribution of cardiac output) [6]. For e.g. in ergometer cycle exercise, oxidative (ATP generation) capacity of vastus lateralis is more, compared to treadmill runners. But these changes during aerobic training are individualized. There is an increase in glycogen content, number of mitochondria and its volume, ATP at rest, glycolytic enzymes, and aerobic enzymes after training. Slow twitch muscle fibre type increases stroke volume, cardiac output, heart volume but resting pulse rate and, heart rate decreases. Loss of physiologic and performance adaptations occurs when a person stops regular physical activity. [6]

PHYSIOLOGIC RESULTS OF EXERCISE TRAINING: [6, 12]

Physiologic and metabolic adaptation occurs in aerobic system in relation to oxygen transportation and consumption. It depends on age, gender, sex and health status of the individual. Metabolic adaptation includes large and increased mitochondria, up to two fold increase in enzyme system, [5] great increase in sarcolemmal interfibrillar muscle to generate ATP in aerobic system allowing a person to restrict the lactate accumulation (anaerobic products) during a prolonged period. Dose of the exercise plays a key role, regarding effects produced on regular habitual exercise to reduce cardiovascular mortality. Slight increase in expenditure of energy from less than 500 k cal per week to 999 k cal per week leads to gross reduction in cardiovascular mortality. Regular aerobic exercise provides greater fitness and reduces the risk of developing cardiovascular events. Aerobic exercise may reduce blood pressure, reduces diabetic incidence, and definitely improve lipid profile [12]

FAT METABOLISM: [6]

Exercise training increases oxidation of fatty acids during rest and sub maximal exercise and the effects are seen within two weeks of the training. Another impressive thing in trained muscle is that it has more capacity to utilize intramuscular triacylglycerol as the primary source for energy. This is possible by

- Increase in blood flow to trained muscle.
- Increase in fat mobilization and metabolizing enzyme activity
- Increase in mitochondria capacity within muscle
- Decreased catecholamine release

Enhanced fatty acid oxidation, is advantageous as it conserves glycogen stores. This increases endurance capacity.

BODY COMPOSITION CHANGES: [(6)]

Regular endurance training for obese individuals reduces the body mass index and produces favourable fat distribution in the body.

EFFECT OF EXERCISE ON LIPIDS [(6)]

The effect of exercise plays vital role in reducing cardiovascular disease. It lowers VLDL, LDL, TC, and raises HDL. A meta analysis of fifty studies showed moderate intensity exercise, involving 4500 persons who exercised 3 to 5 days in a week for at least 12 weeks, where LDL decreased by 5 percent, TGL decreased by 3.7 percent and HDL raised by 4.6 percent. Similarly twenty weeks cycle training for sedentary individuals showed elevated HDL cholesterol, increase in about 1.5 mg/dl, transient reduction in VLDL, triglycerides and total cholesterol, when combined with diet, it reduces LDL cholesterol [(6)]. If it is possible to reduce the lipid level in the blood by exercise, cardiac mortality and morbidity is grossly reduced with the reduction in the atherosclerotic lesions and reduction in the progression of atherosclerosis. [(4)]

EFFECT OF EXERCISE ON WEIGHT :[(6, 13)]

Loss of weight is associated with the good improvement in the lipid profile, blood pressure and glycemic control (control of type-II diabetes).

Diet alone reduces:

- TGL level: 3 to 45 percent,
- Total cholesterol: 1 to 18 percent, and
- LDL cholesterol: 3 to 25 percent

Average weight loss is 1.5 to 3 kg those who do exercise regularly. Thus exercise plays very important role in weight loss and has a synergetic effect when combined with diet

FACTORS AFFECTING AEROBIC TRAINING RESPONSES : [6, 14]

- 1. Intensity of the training,
- 2. Frequency of the training, and
- 3. Duration of the training.

INTENSITY OF TRAINING: [6]

It depends on the overload principle that leads on to physiologic adaptations.

Different ways to express the intensity of training are:

- Energy expended per unit time
- Exercise below or above lactate threshold
- Exercise heart rate
- Metabolic energy expenditure(METS)
- Rating of perceived exertion.

FREQUENCY OF TRAINING: [6]

Cardiovascular improvement is influenced by frequency of training according to some investigators, while others say exercise intensity and the duration influences cardiovascular improvement rather than frequency alone. The answer is elusive. But velocity of oxygen consumption VO_2 max is similar in interval training of two days per week or five days per week. To produce a good weight loss and meaningful exercise, the session should last at least 60 minutes at sufficient intensity to expend more calories. Training of very less frequency does not increase the aerobic capacity or body composition. Aerobic training stimulation is closely related to exercise intensity and total work and not to the sequencing of training days [6]

DURATION OF TRAINING: [6]

It depends upon initial fitness of the individual before the start of the training. For sedentary individuals 3 – 5 minutes daily exercise period produces some improvement in unconditioned people, instead 25 to 35 minutes produce optimal results if intensity is above the threshold. If more time taken for workouts, it does not compulsorily convert to greater improvement (especially in active individuals). Even if the individual exercises twice daily much same volume compared to once daily, does not show any difference in power, performance time and endurance [6]

EXERCISE MODE [6, 14, 15]

Consistency in exercise intensity, frequency and duration produce same training response irrespective of training mode, if big muscle is involved in training, for example ergometer cycling, treadmill walking, running, swimming, skipping rope, stepping, stairs climbing produces excellent favourable results. Based on these concepts, specificity lies only on the training and testing modes. If a person trained in ergometer bicycle shows good improvement when testing is done only in bicycle and not on the treadmill. Similarly when the individuals trained in swimming shows good improvement when tested for upper body exercise.

Recommendation by **ACSM and AHA** [14] for healthy adults of age between 18 to 65 years are

- Physically active lifestyle should be maintained by 18 to 65 years age group

- Moderate intensity training aerobic (endurance) physical activity to be performed.
- Combination of moderate intensity training in addition to the light activities during day to day practice
- Moderate aerobic activity involving 30 minutes of brisk walking which accelerates the heart rate
- Vigorous intense activity is equal to rapid breathing and substantial increase in heart rate
- Adults will benefit at least twice each week by exercising major big muscle to increase muscular strength and aerobic fitness

MAINTENANCE OF AEROBIC FITNESS: [3, 6, 12, 14, 16, 17]

Optimal frequency and duration of exercise maintains aerobic improvement with training. Healthy adults who are engaged in 10 weeks of training in ergometer cycle and treadmill running for 40 minutes, **6 days a week** with VO_2 maximum 25 percent but then after that they continue exercise for another 15 week with same intensity and duration but with **decreased frequency** of **four or even two days per week**. In spite of reduction to two third of exercise frequency, still they maintains the same aerobic fitness.

Components more than VO_2 max , is the reduction in pre-exercise glycogen stores that leads to reduced aerobic capacity levels and diminished level of fat oxidation during exercise. In aerobic training, quality of life improves well because of increased functional capacity and over all energy expenditure. Long term maintenance of exercise training imparts constant challenge due to long term adherence of the formal exercise program; instead it is essential to maintain physiological adaptations. Many of these favourable effects disappear on detraining. Even moderate intensity exercise is a potent stimulating factor for good improvement in the endothelial dysfunction. Exercise enhances the flow shear stress to the endothelial cells, which in turn stimulates e-nitric oxide synthase (e-NOS) and produce nitric oxide leads to vasodilatation. Finally exercise is a medicine to restore the normal health and prevent disease. Favourable adaptation in oxygen transport system, with increase in peripheral oxygen utilization by exercising muscle is also a result.

AEROBIC TRAINING METHODS [6]

Two factors are involved in the aerobic training process:

- Cardiovascular system overload is sufficient to increase stroke volume and cardiac output
- To increase local circulation and metabolic machinery in specific exercised muscle

proper endurance training of specific muscle involved in particular activity for e.g. cyclist must ride cycle, treadmill runner should run, swimmers must swim, in order to over load cardiovascular system for increased oxygen transport and oxygen utilization.

- Two modes of training intensity to improve aerobic system are
  (1) Interval method of training
  (2) Continuous method of training

INTERVAL TRAINING: [6]

Extraordinary amounts of intense physical activity is possible, with proper **spacing of exercise and period of rest intervals,** this involves

- Exercise intensity interval
- Exercise duration interval
- Recovery interval

All these are applicable in treadmill running, ergometer cycling and stair climbing. The rationale behind interval training is that when an intense exercise is performed continuously it leads to enhanced anaerobic glycolysis with increased accumulation of lactate, which consequently ends in fatigue. But this is not the case with interval training, where less accumulation of lactate occurs hence less muscle fatigue and quick recovery is ensured.

CONTINUOUS TRAINING (6)

For slow, long distance training or continuous training, this type of prolonged exercise is possible in moderate exercise pattern retaining high aerobic capacity of 60 to 80 percent of VO_2 max. Various methods were adopted to ensure aerobic capacity for heart rate maximum. This type of training indicated where high intensity is not possible in the people with risk of coronary heart disease. This type of training produces, aerobic adaptation at cellular level and suits those who wish to lose weight.

CALORIC BURNOUT IN DIFFERENT EXERCISE MACHINES (18)

Caloric burnout depends upon stride rate, stride length, belt speed, and elevation if exercise machine is a treadmill, resistance power output if exercise machine is a cycle. In treadmill, part of the body weight is supported which results in significant over estimation of caloric expenditure. MET (Metabolic equivalent) for an adult 1 MET is derived from average, seated, resting energy is about 3.5 ml per kg minute of oxygen if 6 METS would require 6 times the basal expended at rest.

MOTION SENSOR (`18, 19)

The most familiar motion sensor is pedometer, which records the distance travel by foot. It quantifies the movement. Electronic motion sensors that measures both frequency and intensity of movement are called accelerometers. For moderate exercise, walking speed is about 100 steps per minute, at least 30 minutes per day for 5 days in a week of brisk walking. Latest recommendation for moderate physical activity by American Journal of Preventive Medicine recommends that exercise amounted to 92 to 102 steps per minute for adult men and 91 to 115 steps a minute for adult women [19]

ECONOMY AND EFFICIENCY OF EXERCISE : (18)

Law of thermodynamics i.e. law of conservation of energy states that energy can neither be created nor destroyed but it can be changed to another form. During exercise, actual work performed represents only a part of total energy used; the remaining energy is dissipated as heat, and so body temperature rise. The percentage of energy input that appears as useful external work called **mechanical efficiency**.

There are three types of mechanical efficiency

- 1. Gross efficiency
- 2. Net efficiency
- 3. Delta efficiency. Of these three efficiencies, delta efficiency is the most accurate and commonly used

<u>CURRENT GUIDELINES FOR AEROBIC EXERCISE INCLUDES</u> [3]

- All age group to perform exercise at moderate intense physical activity for 30 to 60 minutes per day 4 – 6 times a week.
- Recommended aerobic activities are cycling, brisk walking, swimming, etc
- Resistance training may be added, twice in a week to improve the muscle strength specially over shoulders, arm, trunk, chest, back, legs, and hips.

<u>RISK FACTORS FOR DEVELOPING CARDIOVASCULAR DISEASE:</u> [13,14]

- For every 30 mg/dl increase in LDL level, there is 30 percent increase in risk of CVD.
- Order of atherogenicity: Smaller LDL > Larger LDL > VLDL > IDL > Smaller VLDL > Larger VLDL
- Low level of HDL is associated with increased risk of developing atherosclerosis
- Low HDL with increased TGL are at higher risk [14]

Abdominal obesity and low HDL cholesterol are part of **metabolic syndrome**. Aerobic exercise activity with weight loss has significant impact on HDL. Excess carbohydrate (high glycemic index foods) in diet leads to reduced HDL cholesterol level [11]. Meta analytic studies showed reduction of nearly 1.6 mg/dl of HDL level for every 4.5 kg weight lost. Higher intake of omega 3 fatty acid in marine based food, increases HDL level specially in Eskimos (Arctic region). Aerobic exercise increases HDL cholesterol about 5 to 10 percent, due to raised lipoprotein lipase activity. Cigarette smoking severely impairs lecithin cholesterol acyl transferase activity which reduces HDL cholesterol [(12)]

In metabolic syndrome, all components are addressed with exercise; hence exercise is a mainstay in treatment.

In the clinical practice **5 A's** approach are 1. Ask (benefit person identification) 2. Advice (planning individualized to particular patient) 3. Assess (present activity level) 4. Assist (with a pamphlets or descriptive materials) 5. Arrange (referring services to appropriate persons)

SEDENTARY ENVIRONMENTAL DEATH SYNDROME (SEDS) [(6)]

This term was coined by Dr. Frank Booth as prevalence of chronic diseases are more with physical inactivity. **SEDS** is associated with **high blood pressure**, **high TAG, high total cholesterol, high blood sugar (type 2 diabetes), arrhythmias, CCF, obesity, breast cancer, depression, chronic back pain, spinal cord injury, stroke, disease cachexia, debilitating illnesses**, frequent falls that leads to **hip fractures**, **vertebral compression fractures** and **femoral fractures.** [(6)]

CARDIOVASCULAR ADAPTATION DURING AEROBIC EXERCISE: [(6)]

This is important for enhanced delivery of oxygen to the exercising muscle. Both eccentric and concentric hypertrophy occurs in exercise training which modifies contractile apparatus. The changes that occur are enhanced sensitivity to calcium which changes force length relation and enhanced power output, overload to myocardial tissue stimulates increased cellular protein synthesis.

STROKE VOLUME: [6]

Aerobic training raises the stroke volume even at rest by increased LV volume, increased diastolic filling time (due to reduction in pulse rate), and improvement in cardiac muscle contractility.

EXERCISE AND MAXIMAL CARDIAC OUTPUT: [6]

Average cardiac output during moderate exercise increases by 8 percent, reflecting two factors. They are: (1) Increased redistribution of blood flow
(2) Trained muscle has increased capacity to produce ATP aerobically even in lower partial pressure of oxygen.

OXYGEN EXTRACTION (A-V OXYGEN DIFFERENCE): [6, 18]

Aerobic exercise training increases the oxygen extraction i.e. A-V oxygen difference in circulating blood is due to increased cardiac output

MYOCARDIAL BLOOD FLOW: [6]

Physiologically structural and functional changes occur in heart vasculature and in the cardiac muscle. Structural changes include increase in cross sectional area of the proximal coronary arteries, possibly by proliferation and growth, increased collateral and enhanced capillary density. (1) Structural remodelling, (2) Effective control of vascular resistance

BLOOD PRESSURE: [6]

Regular aerobic training decreases systolic and diastolic pressure during rest and during moderate exercise

PULMONARY ADAPTATION WITH AEROBIC TRAINING: [6]

Aerobic training stimulates the dynamics of pulmonary ventilation during moderate exercise. At a given exercise intensity, breathing effort is minimised on aerobic training. Consumption of oxygen reduced by ventilator musculature due to exercise are

- Reducing the effect of fatiguing on ventilatary musculature.
- Oxygen freed from ventilatory musculature is available to active locomotor muscles.
- Overall, it raises the tidal volume and reduces frequency of breathing.
- Because of this air in the lungs stays longer between breathing, increasing oxygen extraction from the already inspired air.
- The ventilator response is relatively different, for different type of exercise performed (arm only, leg only exercise) and with different training adaptations. These adaptation includes
  1. Reduction in overall energy demands since less respiratory work.
  2. Reduced lactate production by ventilatory muscles during prolonged exercise

BLOOD LACTATE CONCENTRATION:

Overall effect of an aerobic training is the lowering of blood lactate concentration by central and peripheral mechanical adaptation to endurance training

1. Reduced lactate formation
2. Increased lactate removal during exercise
3. Combined effects of reduced formation and removal

PSYCHOLOGICAL ADVANTAGES: [6]

Regular aerobic training individuals, regardless of age, have greater impact on psychological aspects. Benefits attained by exercise are

1. Decreased level of anxiety
2. Decreased mild to moderate depression
3. Decreased neuroticism- seen in long duration exercises
4. As a adjuvant to pharmacological therapy for severe depression
5. Elevates mood, self concept and self esteem

AIM AND OBJECTIVES

AIM:

The aim of the present study is to investigate the effects of 12 weeks aerobic training (tread mill running and ergometer cycling) on lipid profile.

OBJECTIVES:

To study the effects of 12 weeks aerobic training on lipid profile [total cholesterol (TC), triglyceride (TGL), very low density lipoprotein (VLDL), low density lipoprotein (LDL), high density lipoprotein (HDL), total cholesterol/high density lipoprotein ratio (TC/HDL), low density lipoprotein / high density lipoprotein ratio (LDL/HDL)]. To compare the effects of aerobic exercise (treadmill running and ergometer cycling) and the control (sedentary) group between pre test (baseline) and post test for the each group. And to compare the tread mill and the ergometer cycle, to identify as to which is the best in favouring a lipid profile outcome.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

"George A Kelley" observed the effects of aerobic exercise on lipids and lipoprotein in women. This study used meta-analysis of randomized controlled trials using retrieved information from computer data in journals, references, and expert reviews of nearly 48 years. Most studies assessed primarily TC, TGL, LDL and HDL. These studies were based on aerobic training, done in walking exercise as primary modality, a few groups did cycling, stair climbing and aerobic dancing etc. Average length of the training period was 21.8 ± 19.45 weeks, intensity of the training was 69.2 ± 10.1, frequency of training 3.7 ± 1.1 times per week, duration of the training was found to be 36.3 ± 13.2 min/session, compliance of the training 86.1 ± 13.5, and the primary outcome of most studies were significant reduction in TC, TGL, LDL and elevation in HDL with P value of <0.001 and secondary outcome was found to be a significant reduction in body fat and improvement in the ventilatory oxygen consumption. As on majority of the studies that followed the ACSM for developing and maintaining cardio respiratory fitness in adults showed at least 5 percent improvement on adhering to this guideline which includes aerobic exercise performance for about 3- 5 days in a week, and for 20 to 60 minutes; continuous exercise with 55 to 90 percent of maximum heart rate. Injury risk is very low in walking compared to other modalities of exercise training. Every 1 percent reduction in LDL will reduce 1 percent reduction cardiac heart disease occurrence [(20)].

Annei et al', compared the energy expenditure in different indoor exercise machines. This study compared six different modalities of exercise machines, 1.Treadmill 2. Ergo meter cycling, 3.Airdyne 4. Rowing ergo meter 5.stair steeper and 6.a cross country siding simulator. Heart rate variability was significantly more with treadmill and step climbers, lactate threshold also varied, being highest with step climber and rowing ergo meter. Results proved that the treadmill is the optimal indoor exercise machine for increasing energy expenditure when rate or perceived exertion is used to calculate the intensity of the exercise training [21]

'Leon and Sanchez', et al did a meta-analysis of 51 studies for 12 weeks of aerobic intervention where more than 4,500 subjects were participated and reported their results as LDL cholesterol reduction by 5 percent, triglycerides reduction by 3.7 percent, HDL cholesterol elevation by 4.6 percent and marked improvement seen in HDL: LDL ratio, these results insist that aerobic exercise impacts LDL and TGL whenever the exercise is performed at higher intensity [22]

"Tolfrey K"., observed the effect of exercise training on lipid profile in pre-pubertal children compared with the controls. Training involves stationary cycling for 30 minutes thrice in a week for 12 weeks at an average peak heart rate of 79 per minute. Pre and post test lipid profile testing were done. Results showed LDL level was significantly lower; HDL increased, reduction in TC/HDL ratio and LDL/HDL in exercise trained group, but unchanged in controls. These favourable changes are independent of changes in the peak velocity of oxygen consumption. The conclusion of this study shows favourable improvement in the lipid profile in exercise trained group compared to control group [23]

"Lippi G," observed marked beneficial effects of physical activity and longevity due to the favourable effects on lipid profile. But the main debate is still on the level of intensity of the training whether to go for high intensity or moderate intensity training. Little is known so far on the effect of a vigorous exercise and regular aerobic training on new risk factors like lipoprotein (a), TC/HDL ratio and atherogenic index of plasma. A study evaluated in 60 male sedentary controls, 40 male professional cross country skiers and 102 male professional cyclists. TC, LDL, Atherogenic index were significantly lower in the athletes, mean HDL cholesterol level was higher but the concentration of lipoprotein (a) group had no changes between groups. Reduction of TC/HDL, in professional skiers and cyclist reflects that there is significant increase in aerobic physical activity in these groups compared to other professional athletes. Hence increased aerobic physical activity within the population is recommended especially for subjects with higher cardiovascular risk (24)

"Giada F." in his study compared the influence of age on physical training and detraining. Body composition, plasma lipids, and cardiovascular performance were studied. The study was conducted in older and younger age groups. Twelve male cyclist participated in the study, with age matched controls. This study showed favourable outcome in both the study groups and increased aerobic power in the training group whereas two months discontinuation of the training (detraining) showed significant, unfavourable results.(25)

Thomas TR et al, compared substrate utilization and energy expenditure during sixty minutes of similar heart rate in four different modalities of exercise 1. Tread mill walking 2. Stationary cycling 3. Ski simulator, and 4. Rower. This study concluded that the energy expenditure and fat utilization rate were higher for tread mill and skiing group compared to other modalities (26)

"La fortuna CL" compared aerobic, strength and anaerobic performance changes in three weeks duration of different type of exercises varying the volume and intensity. It concludes moderate intensity exercise training groups offers better results because of increased muscle performance and increased physical fitness with stronger motivation to future exercise programs (27)

"Jonathan M. Oliver" compared the three different modes of exercise for short term changes in LDL. Study group was divided into resistance, endurance, or combination of resistance and endurance training individuals, ANOVA analysis showed LDL is significantly lower both in resistance and endurance training group [28]

“Ravikiran et al” studied the effects of the treadmill and bicycle ergometer on cardiovascular responses and showed that the cardio vascular change depends upon the type and intensity of exercise. Both treadmill and ergometer cycling have different group of muscles involved in exercise. In treadmill group, heart rate, systolic blood pressure was more compared to cycle group. But there was no significant change in diastolic blood pressure [29]

“Kodama S et al” [30] in a meta analytic study, observed the influence of aerobic exercise on HDL cholesterol and in their analysis it showed, no significant correlation between exercise frequency or intensity of the exercise training. They concluded that the most important factor in exercise was the duration per session to raise the HDL cholesterol

“Raveenan Sitiwicheanwong, et al” studied the effects of moderate exercise training on LDL for twelve weeks in sedentary women. Triglycerides, triacylglycerol-rich lipoproteins, small dense LDL, large buoyant LDL, and its ratio were significantly reduced in exercise group compared to the control group [31]

“Thomas S Metkus et al” observation gave a practical approach to prescribe exercise just like any other drugs to prevent primary prevention of CVD. They coded the advantages and benefits of both aerobic and anaerobic exercise and probed the exercise effects on different cardiac risk factors, in case of dyslipidemia. Meta-analytic results showed significant raise in HDL level, in diabetic patients significant lowering of Hb A1 c level, and in hypertensive patients significant reduction in blood pressure. Good lifestyle modification and psychosocial health were also seen in the regular exercise group. This panel recommended aerobic exercise (stair climbing, cycling, treadmill walking, elliptical machine, swimming) of moderate intensity, at least 5 days in a week for 30 minutes or a vigorous intensity exercise like running, single tennis and swimming, at least 3 days in a week for 20 minutes each and resistance training of push ups, bent rowing, toe raises, bent-knee abdominal crunches, at least 2 days per week, of 8-12 repetitions per single set twice per week, and increasing fibre content in the diet, fruits, fish and MUFA (olive oil) [(32)]

"Valeria Sales Do Valle et al" studied the effect of indoor cycling and diet on serum lipid profile, cycle alone or cycle with diet restriction or diet alone compared with control group for 12 weeks. Aerobic exercise intervention showed significant favourable outcome on lipid profile (TC, LDL, VLDL, HDL) in exercise group and diet restricted group compared with sedentary control group who had unfavourable result [(33)]

"**Aryvdaas Stasiulis et al**" studied the changes in lipid profile in 18 to 24 year age group women in 8 weeks of aerobic training on ergometer cycle. Body composition, TC, LDL HDL, TGL, and TC were assessed before the experiment (pre test) and post test values at 2,4,6,8 weeks showed significant favourable lipid profile changes that starts to occur only at 6^{th} week but at the completion of exercise at 8 weeks all parameters showed favourable lipid profile and the results were significant when compared to sedentary controls [(34)]

"**Tambalis K et al"** observed the effect of blood lipids to aerobic, resistance, combined mode of exercise for 12 weeks. Results revealed that high intensity aerobic exercise training had elevation of HDL cholesterol in adults which is independent of the age and sex of the individual [(35)]

Mann S, Beedie C, Jimenez A, reviewed (journal published 1975 - 2012) different types of aerobic exercises, resistance training and combined modes of exercise on lipid profile and showed the beneficial effects of regular physical activity on improvement in cholesterol levels. Aerobic exercise (endurance exercise like running, cycling, and jogging) at increased intensity and duration produced a positive effect on lipoprotein lipase activity, elevated HDL levels, and had a favourable lipid profile. The overall review of many studies suggests that the aerobic exercise should be of moderate intensity and high intensity exercise does not show any special improvement, so moderate aerobic exercise is recommended [(36)]

"Le Mura LM et al" observed the effects of different modes of training on lipid profile, body composition and cardiovascular fitness after nearly sixteen weeks of training and six week of stopping all activities (detraining period) in young women. All study groups underwent training for 16 weeks and after completing this period, all subjects were examined for lipid profile, body composition, cardiovascular fitness, and dietary composition and similarly tests were done after 6 weeks of detraining period. In aerobic training group, there was significant reduction in triglycerides and elevation in HDL cholesterol and it correlated well with reduction in body fat percentage, and increase in velocity of oxygen consumption by about twenty five percent. But the resistance training and cross training group did not have significant changes in total cholesterol, triglycerides, and HDL concentrations. The overall results of this study showed that there is marked improvement in the aerobic exercise on lipid profile, body composition and cardio respiratory fitness in young women, which is not seen in resistance training group [(37)]

O Donovan et **al"** observed the effects of aerobic exercise of moderate intensity for 24 weeks, 3 sessions per week, which showed significant reduction in total cholesterol, LDL cholesterol [(38)]

‘Kraus et al’, studied the importance of **volume** as well as the **intensity** of exercise on lipid profile. Three types of aerobic exercises were performed **high volume and high intensity**, **low volume** and **high intensity and low volume and moderate intensity. High volume** and **high intensity** training had significant improvement in the LDL, HDL, TGL proving clearly that the total expenditure of energy, plays key role in favourable lipid profile [39].

Prabakaran et al, assessed the effects of resistance training for fourteen weeks, three sessions per week, which showed that there was significant reduction in total cholesterol and LDL cholesterol, **moderate intensity resistance** training gave more favourable outcome than high intensity training [40]

Kravitz et al, compared energy expenditure and VO_2 during treadmill running, cycle ergometer, simulated cross country sky. Results showed treadmill exercise is the modality of choice for individuals who try to improve cardio respiratory endurance and expend high energy expenditure [41]

Rowland et al, studied the delta muscle work efficiency during moderate exercise (cycling and treadmill walking) for male and female children and showed no significant difference between the male and female children in utilization of energy during sub maximal exercise [42]

Minetti AE, studied the metabolic energy expenditure on cycling in different frequencies of lower limb movements, as pedalling frequency increases, it utilizes the extra metabolic expenditure of energy [43]

Blanca roar Moraleda et al”, observed the effects of different modalities of exercise on lipid in overweight individuals. Results showed, no significant difference between different modalities of exercise training (aerobic, resistance, combined) [44]

Kenneth et al', compared the effects of cardiovascular responses to treadmill and ergo meter cycling between adults and children. The results showed, cardiovascular responses were different in children and adults and these differences were highly related to the size of the heart and amount of muscle doing the work and are not absolutely exercise dependent [(45)]

Sullen S et al, observed the controversial results and revealed that the effects of aerobic, resistance and combined modes of training for twelve weeks. Obese individuals on cardiovascular risk showed significant weight loss and improvement in cardio vascular fitness in combined modality, but there was no significant improvement in the aerobic or resistance training when done alone [(46)]

Narges Argani' compared the effects of different exercise intensities on bicycle ergometer on postprandial lipidemia in diabetic patient. In this study, moderate exercise group had more HDL than high intensity group and moderate intensity group had more reduction in the TGL level compared to high intensity group. But no significant change is seen in LDL, whether it is moderate or high intensity group. This study concludes that regular aerobic exercise in moderate intensity causes lipid oxidation, raised muscular activity, raised liver lipoprotein, which decreases triglyceride level and raises HDL level [(47)]

Mengistic alemayehu belay et al, observed the independent effects of aerobic and resistance exercise training on obesity. This study investigated various parameters which include body weight, composition, metabolic variable (blood cholesterol), blood pressure, VO_2 max and muscular strength, cardio respiratory fitness, for twelve weeks of moderate intensity. Pre test (baseline value) versus post test values showed there was significant improvement in body fat percentage, visceral fat, BMI, TC, VO_2 max and skeletal muscle strength from the base line. Combined aerobic and resistance training (CART), brought significant improvement [(48)]

“Taralov Z”., observed the effect of physical activity on lipid profile in adolescent and mature human beings. This study compared the effects on lipid profile in athletes and sedentary individuals, showing statistical significant reduction in total cholesterol, triglyceride, but no significant difference in HDL cholesterol level [(49)]

Ahamadi Pezhman et al’ observed the effects of TGL on erogmeter cycling. Pre and post tests results were compared, and there was no significant difference between pre and post test triglyceride, total cholesterol and LDL [(50)]

AJ schuit et al’ observed the impact on aerobic training program for six months in 60 to 80 years age group men and women on lipid profile and showed no significant change between pre and post tests results, implying that in the elderly for a change to occur, it takes longer compared to younger individuals. Vigorous activity is not always possible in elderly individuals to mobilize lipoprotein lipase from muscle [(51)]

Fahlman MM, et al”, studied the effects of aerobic training and strength training on lipid profile in elderly women. Exercise intervention was done for 3 days in a week, 70 percent of heart rate reserve; total duration of the study was 10 weeks. Results showed both in strength training and aerobic training groups were experiencing raised HDL cholesterol and reduced triglyceride at 10 weeks compared to baseline samples [(52)]

Eric C. Freese et al’ quantitatively reviewed the effects of prior exercise on postprandial lipidemia; it is a meta-analytic review of literature and showed that postprandial lipemia depends upon on the type, intensity, energy expenditure, and sex of the individual [(53)]

Yiannis E. Tsekouras et al’ studied the effects of aerobics in high-intensity training and observed decrease of VLDL and triglyceride in men. Results showed significant difference in VLDL and triglyceride concentration in training group (pre and post tests), compared to control group (pre and post tests) [54]

Christopher J. Retallick et al, studied the effect of ergometer cycling on lipid profile and showed significant reduction in triglyceride, total cholesterol and LDL, and elevation of HDL [55]

Faidon Magkos et al' studied the effects of lipid metabolism in a single bout of aerobic exercise in seven men of mean age group twenty eight years, after two hours of ergometer cycling and at rest, The results showed significant raise in free fatty acid after two hours of cycling. [56]

Faidon Magkos et al' studied the effects of VLDL changes in acute exercise on aerobic (low intensity endurance exercise) or resistance (high intensity) training. There was significant reduction of VLDL in resistance training group, but not in aerobic training individuals. [57]

Tudor-Locke and Bassett DR studied how many steps were required in a pedometer to improve health. They showed that both men and women have to roughly take 100 steps per minute. [58]

Jeffrey F Horowitz and Samuel Klein' studied the changes occurring during the aerobic exercise on lipid metabolism and observed that an aerobic trained individual oxidizes more fatty acid without much lipolysis. [59]

Rikke Krogh-Modsen et al" studied the effects of physical activity and intake of high calorie diet and showed normal physical activity definitely prevents rise in plasma lipid though the subject consumes high calorie diet. [60]

Patrick M. Davitt et al', studied the effects of free fatty acid metabolism and postprandial triglyceride in overweight women on aerobic exercise, and strength training exercise. They showed significant reduction in plasma triglyceride in comparison with the control group. [61]

Kim M. Huffman et al' studied the approach of how to reduce the cardiovascular events in dyslipidemic patient by changing the life style (physical activity - exercise) and diet and showed beneficial effects are produced when diet is combined with the exercise[62]

Wosornu D et al" observed controversial results and revealed that the effects of aerobic and resistance training for six months after coronary bypass surgery. Results showed there was a statistically significant reduction in weight, BMI, skin fold thickness, lipid profile in resistance training group but not in aerobic training group [63]

Oxidation of fat is increased in aerobic training. This is due to increased mitochondrial density in muscles. Mitochondria are responsible not only for the citric acid cycle and oxidative phosphorylation but also for beta oxidation of fatty acids [64]

MATERIALS AND METHODS

MATERIALS AND METHODS

Participants:

Eighty normal healthy volunteers both men and women were recruited from Thanjavur Medical College Hospital and Raja Mirasudhar Hospital, Thanjavur, in the 25 to 35 years age group, study was conducted between January 2014 and June 2014. This study was conducted in the research laboratory, Department of physiology, Thanjavur Medical College, Thanjavur

Study Design:

Study is a randomized control trial for 12 weeks, observing the effects of aerobic training on lipid profile. Subjects were randomize into three groups

Group A Control Group

Group B Treadmill group

Group C Ergometer Cycle group.

This study included 80 subjects, of these 40 subjects were in control group - Group A (22 were males, 18 were females) and 40 subjects were in aerobic training group (study group). The study group is further subdivided into two groups. Group B consisted of 20 subjects (13 were males, 7 were females) who underwent treadmill training and Group C consisted of 20 subjects (11 were males, 9 were females) who underwent cycling. Pre test and post test lipid profile results of control group (n=40), and aerobic training group (treadmill plus cycle group) (n=40) were compared. Similarly pre test and post test lipid profile results of treadmill group (n=20), and cycle group (n=20) were also compared. The mean difference between pre and post tests of treadmill, cycle and control groups respectively were compared.

Anthropometric measurement of the aerobic exercise interventional group and control group

Table No: 1

Variable	**Tread mill group (n=20) Mean ± SD**	**Cycle group (n=20) Mean ± SD**	**Control group (n=40) Mean ± SD**
Age (in years)	29.45 ± 3.817	30.25 ± 3.795	30.95 ± 3.433
Height (m)	1.615 ± 0.081	1.614 ± 0.081	1.620 ± 0.073
Weight (kg)	67.9 ± 13.920	70.8 ± 15.343	69.05 ± 8.628
BMI (m^2/kg)	26. 042 ± 5.033	27.111 ± 5.110	26.312 ± 3.032

BMI = Height in sq.meter / Weight in kg(Pearson formula)

Age group selected is between 25 to 35 years. Of 20 subjects who participated in the tread mill group, mean age was 29.45 years, mean height was 1.615 m, mean weight was 67.9 kg, and mean BMI was 26.042 m^2/kg. Of 20 subjects who participated in the cycle group, mean age was 30.25 years, mean height was 1.614 m, mean weight was 70.8 kg, and mean BMI was 27.111 m^2/kg. Of 40 subjects in the control group, mean age was 30.95

years, mean height was 1.62 m, mean weight was 69.05 kg, and mean BMI was 26.312 m^2/ kg (Table no: 1)

Before starting our study, we obtained ethical committee approval and clearance from the college. Informed consent was obtained from all subjects who were participating in the study. The purpose of study was explained clearly in their regional language. The history of the subjects was obtained and noted in a separate pro-forma. Subjects included in our study were healthy individuals. Subjects with history of diabetes, hypertension, hyperlipidemia, intake of drugs (lipid lowering drugs), smoking, alcoholism, coronary artery disease, pulmonary illness, endocrinal diseases, and orthopaedic limitation to physical activity were excluded from the study. If an individual was involved in any other exercise activities (including yoga) were also excluded from the study.

For tread mill group subjects, hundred steps per minute for one hour per session, five days in a week for twelve weeks. In cycle group subjects, sixty to seventy revolutions per minute(RPM), fourth resistance in tension adjuster, for fifteen minutes duration, five days in a week for twelve weeks. Both of these protocols were qualified for the **moderate exercise intensity** as per WHO guidelines and AHA guidelines.

INSTRUMENTS USED IN THE STUDY:

1. Treadmill (Cardiotrack 900 XL, Whispermill, Browndove Health care Ltd, Bangalore) (Figure no: 5)
2. Pedometer (Omron health care, Singapore, model No: HJ-005) –To calibrate number of steps in tread mill walking (Figure no: 1)
3. Fingertip pulse oximeter (Model No: MD 300C22 Nidek Medical India (P) LTD, Kolkata) - to monitor heart rate during aerobic training session.
4. Ergometer cycle (Aerofit India, Hyderabad) (Figure no: 4)

PEDOMETER FOR QUANTIFYING NUMBER OF STEPS IN TREADMILL WALKING (Figure no: 1)

TENSION CONTROLLER IN ERGOMETER CYCLE (Figure no: 2)

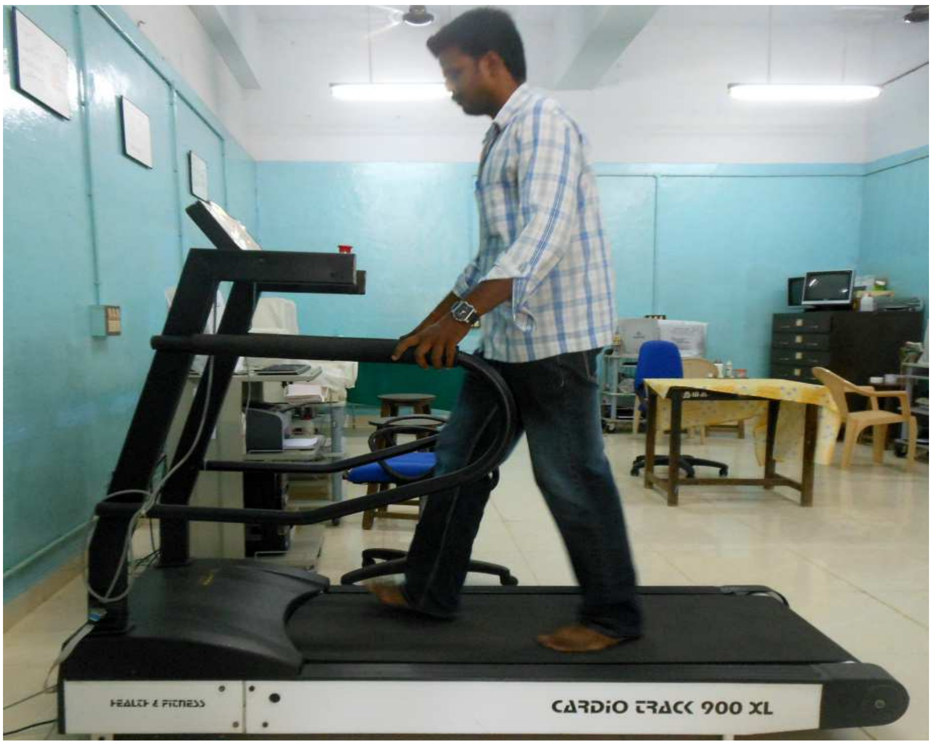
CENTRIFUGE (Figure No: 3)

<u>TRAINING FOR A SUBJECT IN ERGOMETER CYCLE</u>

(Figure no: 4)

<u>TRAINING FOR A SUBJECT IN CARDIOTRACK 900 XL, TREAD MILL</u>

(Figure no: 5)

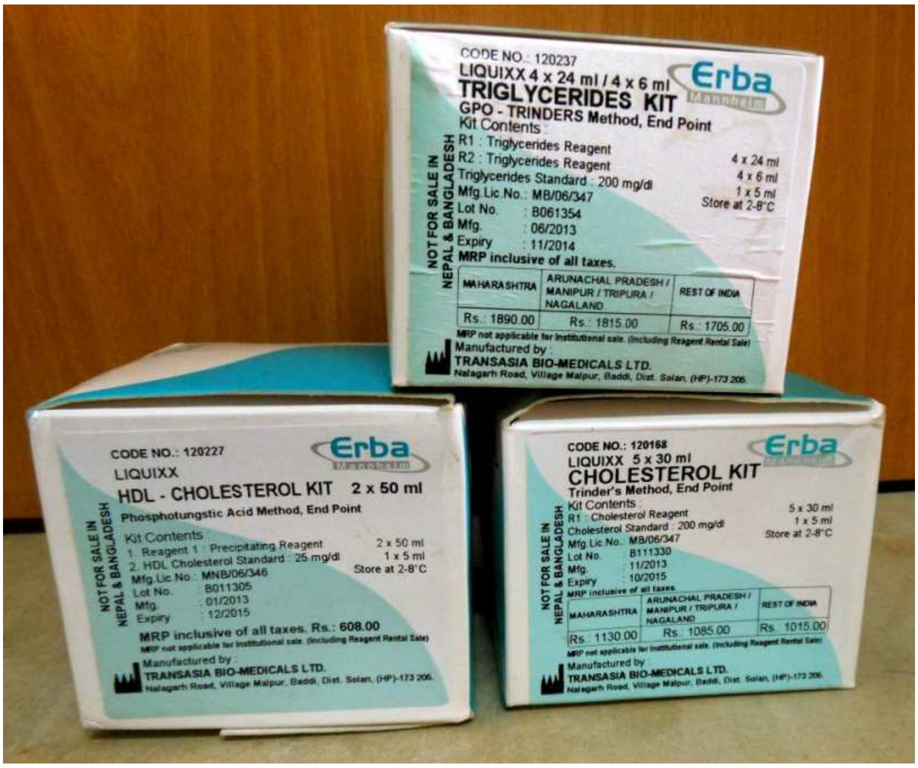


KERAGEN BIOSYSTEMS, SEMIAUTOMATED ANALYSER

(Figure no: 6)

ERBA - HDL, TOTAL CHOLESTEROL, AND TRIGLYCERIDES REAGENTS KIT

(Figure no: 7)



GEL VACCUM TUBES FOR BLOOD COLLECTION (Figure no: 8)

GEL VACCUM TUBE WITH BLOOD (Figure no: 9)

5. REMI centrifuge (Remi, Mumbai, model No: R 8-C) (Figure no: 3)
6. Keragen Biosystem – Semi Auto analyser (Keragen Technologies,Pvt Ltd, Bangalore) (Figure no: 6)
7. Gel tube-vacuum type- (serum separator tube with clot activator) – (Greiner bio-one, Belgium) (Figure no: 8 and 9)
8. Reagents used were ERBA from Transasia Bio-Medicals Ltd, Himachal Pradesh, for total cholesterol, triglycerides, and high density lipoprotein estimation (Figure no: 7).
9. Weighing machine (Krups, India pvt Ltd), height scale
10. Miscellaneous like syringe (Becton Dickinson S.A., Spain), cotton, Spirit etc.

Training Program:

All subjects who are in study group subjected to undergo preliminary training to accustom and familiarize about the instrument which they were allotted for exercise namely treadmill and ergometer cycle. This was to reduce the anxiety and prevent injuries.

All subjects who were participated in the **treadmill group (Group B)** wore a pedometer (to quantify the number of steps, using motion sensor technology) in a belt strapped in their waist, before stepping on to the treadmill. Exercise was performed for one hour. In our study, warm up was done on the treadmill itself for 10 minutes. To start with 1.1 km/hr was gradually increased, and finally attained the desired speed of 3.2 to3.7 km/hr (equivalent to 100 steps per minute in pedometer). Exercise intervention continued in treadmill, 100 steps per minute for 1 hour. This is followed by 10 minutes cool down with light stretching exercises. This qualifies for a **moderate intensity exercise**. Like this, exercise session was followed for 5 days in a week and for 12 weeks for all subjects who were in treadmill group. During the exercise, heart rate and oxygen saturation in the blood was monitored closely using finger pulse oximeter.

Before starting the exercise in **cycle group (Group C)**, seating arrangement was made comfortable and adjusted according to the height of the individual. To start the exercise session, warm up with slow pedalling of 30 to 40 RPM for 5 minutes with resistance level in tension controller (Figure no: 2) is set to first level (equivalent to 1 Kilopond). After completing the warming up, the pedalling speed gradually increased to 60 to 70 RPM for 15 minutes with resistance being increased from 1 to 4 in the tension adjuster gradually. This is followed by 10 minutes cool down with light stretching exercises. Throughout the exercise session, heart rate was monitored in the console on ergometer cycle itself. Like this, exercise session continued for 5 days in a week for 12 weeks.

All of our subjects tolerated the protocol, showed interest, and enjoyed the session. Subjects felt very fresh and more active during the entire day after aerobic exercise.

Measurement of Lipid Profile:

Before starting the exercise intervention, in all subjects (both study group and control group) blood samples were collected for **pre-test evaluation** of lipid profile (base line sample). For all subjects of study group (after 12 weeks of exercise intervention as per protocol) and control group (sedentary non-exercise group) blood samples were again collected for **post-test evaluation** of lipid profile. Comparing and analysing between the pre-test and post-test results in exercise intervention groups and in the control group are of primary significance in our study. All individuals were kept on fast for 12 hours overnight and samples were collected between 8 AM to 11 AM, they are withdrawn from any exercise activities for at least 1day (to minimize the effects of acute exercise on lipid profile). Under strict aseptic precautions, blood sample of 5 ml was collected from all subject by venupuncture (cubital vein). After the blood was drawn in a sterile syringe, it was transferred into vacuum gel tube and the tube was kept straight in tube stand for 20 minutes.

Vacuum containing gel tube (Figure no: 8 and 9) is a type of evacuated blood collection system. The advantage of this gel tube is that it has barrier gel system that helps quick separation of serum from cellular components of blood, which decreases haemolysis. This tube ensures complete separation of plasma, so that lipid profile result is perfect without any error. After clotting, blood transferred to REMI centrifuge (Figure no: 3) and centrifuged at 2000 RPM for 20 minutes. At the end of centrifugation, plasma was separated in the superficial layer, and red blood cells were packed in bottom layer with gel interface in between.

After centrifugation, plasma was separated and analysed in Keragen Biosystem – SemiAuto analyser (Keragen Technologies, Pvt Ltd, Bangalore) (Figure no: 6) in the biochemistry laboratory by standard enzymatic technique CHOD-PAP, End point method (Figure no: 6 and 7). TC, TGL, and HDL noted from the analyser monitor, VLDL, LDL, TC/HDL, LDL/HDL were calculated.

- Very Low Density Lipoprotein = Triglyceride /5,
- Low Density Lipoprotein calculated using the Friedland's formula
- Low Density Lipoprotein = Total cholesterol - (Very Low Density Lipoprotein + High Density Lipoprotein)

This formula can be applied when triglyceride value does not exceed 400 mg/dl. In our study, no sample of triglyceride exceeded the limit of 400 mg/dl; hence we applied this formula for calculation.

RESULTS

RESULTS

The results were analysed in statistical analysis soft ware, SPSS version 21 for windows. Inferential statistical technique was used to compare the means through paired sample‘t’ test. Students paired‘t’ test was used to compare between pre-test and post-test results of control group, treadmill group, cycle group and aerobic training group (treadmill group plus cycle group).

We used a level of significance of 95% (P value <0.05 as significance)

Changes in anthropometric measurements weight and body mass index and lipid profile of individual variables namely TC, TGL, VLDL, LDL, HDL, TC/HDL ratio, LDL/HDL ratio were compared by students paired ‘t’ test, pre-test (before exercise intervention-baseline samples) in all groups and blood samples were collected post test (after exercise intervention) in case of study group (tread mill and ergometer cycle groups), whereas in control group post test [after 12 weeks without exercise intervention (sedentary)]

Similarly, combined tread mill and cycle group (n=40) (aerobic training group) pre and post tests were compared.

Finally the mean difference between pre and post tests of treadmill and cycle groups respectively was studied to know which one is the best instrument and gives favourable results for lipid profile.

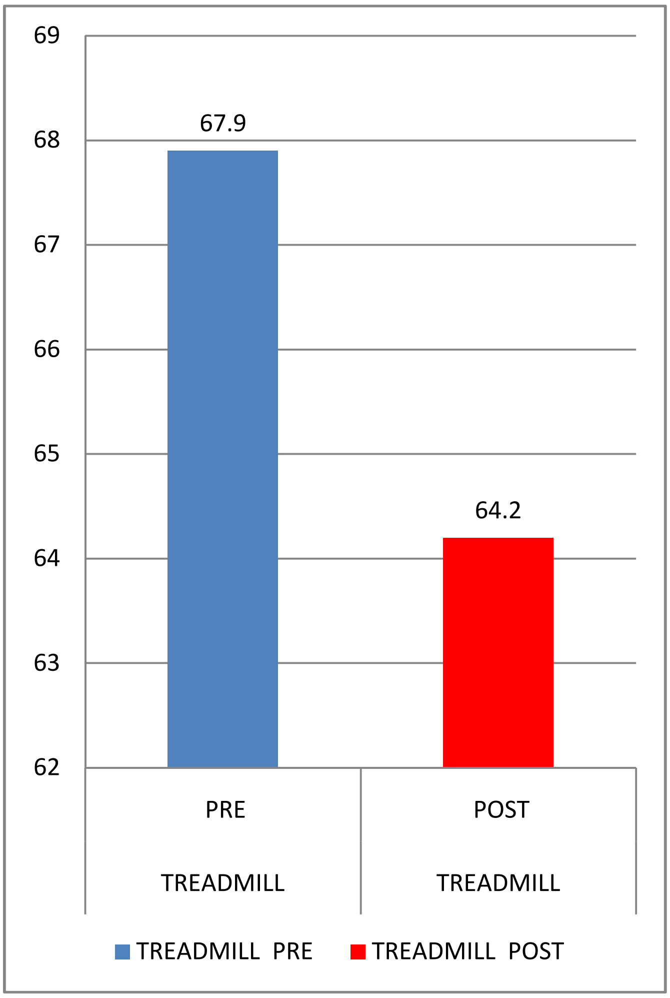
COMPARISON OF PRE AND POST EXERCISE TREADMILL (GROUP B)

(Table no: 2)

Variable	Group B	Test type	n	Mean ± SD	P value
Weight	Treadmill	Pre test	20	67.9 ± 13.920	0.000
		Post Test	20	64.2 ± 11.967	
BMI	Treadmill	Pre Test	20	26.042 ± 5.033	0.000
		Post Test	20	24.611 ± 4.264	
TC	Treadmill	Pre test	20	184.263 ± 21.995	0.000
		Post test	20	177.297 ± 22.427	
TGL	Treadmill	Pre test	20	128.33 ± 16.396	0.003
		Post test	20	119.74 ± 18.479	
VLDL	Treadmill	Pre test	20	25.66 ± 3.282	0.000
		Post test	20	23.94 ± 3.695	
HDL	Treadmill	Pre test	20	37.85 ± 4.597	0.000
		Post test	20	41.58 ± 4.673	
LDL	Treadmill	Pre test	20	120.74 ± 21.374	0.000
		Post test	20	111.76 ± 21.736	
TC/HDL	Treadmill	Pre test	20	4.94 ± 0.891	0.000
		Post test	20	4.32 ± 0.814	
LDL/HDL	Treadmill	Pre test	20	3.25 ± 0.799	0.000
		Post test	20	2.74 ± 0.723	

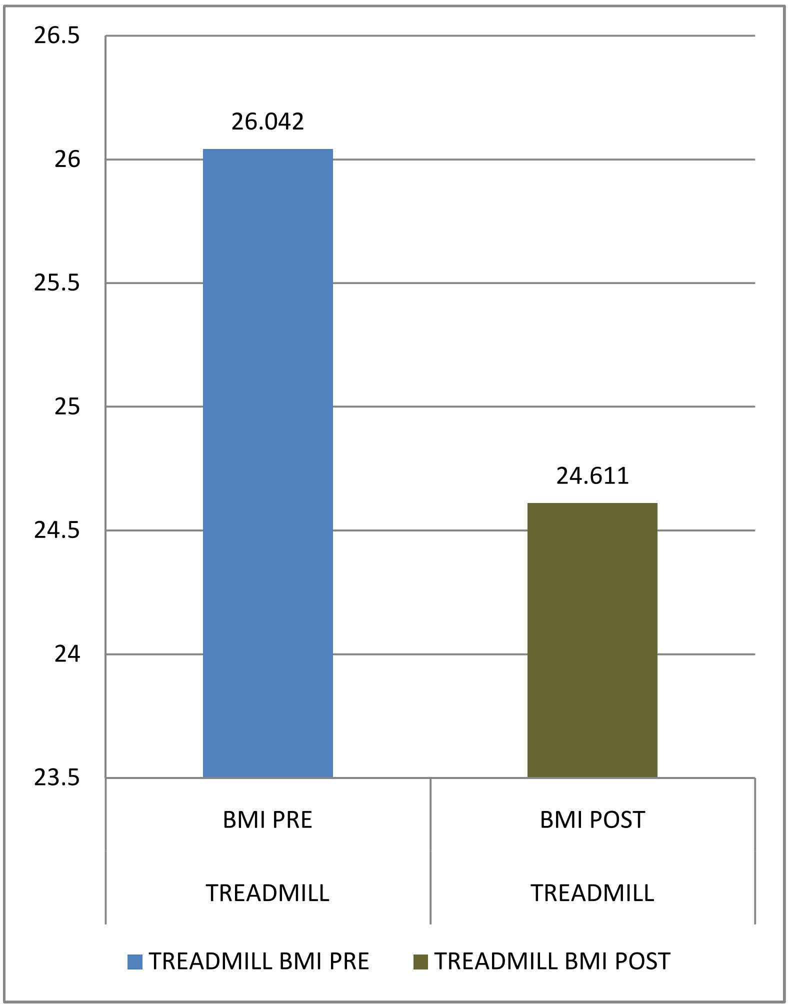
Weight of treadmill group (n=20), pre test (baseline) Mean ± SD showed 67.9 ± 13.92 and post test Mean ± SD showed 64.2 ± 11.96; P value of 0.000 ($P<0.05$), which is a significant reduction in post test compared to pre test.(Figure no: 10) (Table no: 2)

WEIGHT (Fig. no: 10)



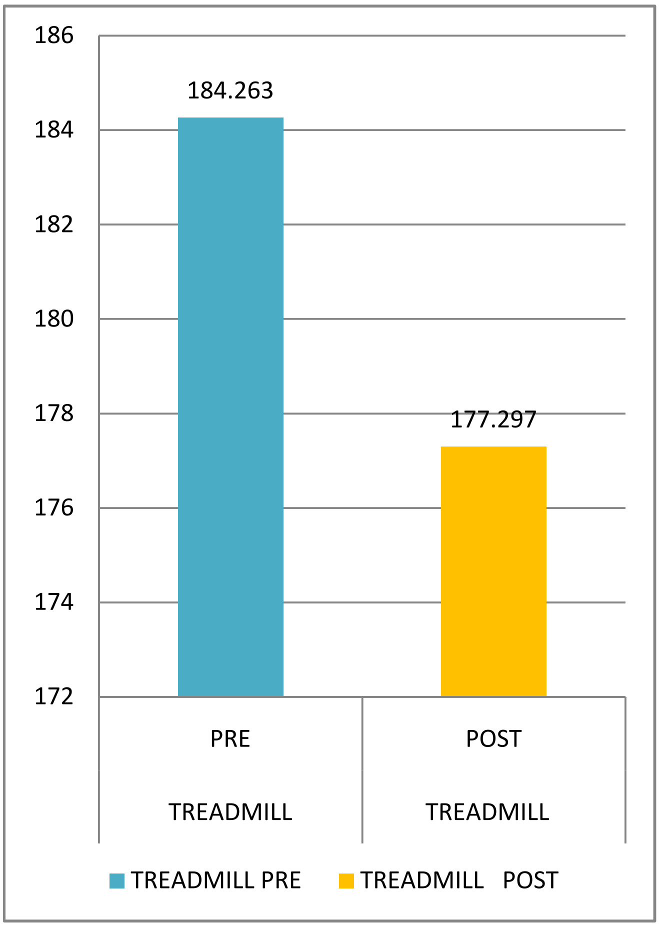
Body Mass Index of tread Mill group (n=20), pre test (baseline) Mean ± SD showed 26.04 ± 5.033 and post test Mean ± SD showed 24.61 ± 4.26 with P value of 0.000 (P<0.05), which is a significant reduction in post test compared to pre test. (Figure no: 11) (Table no: 2)

BODY MASS INDEX (Fig. no: 11)



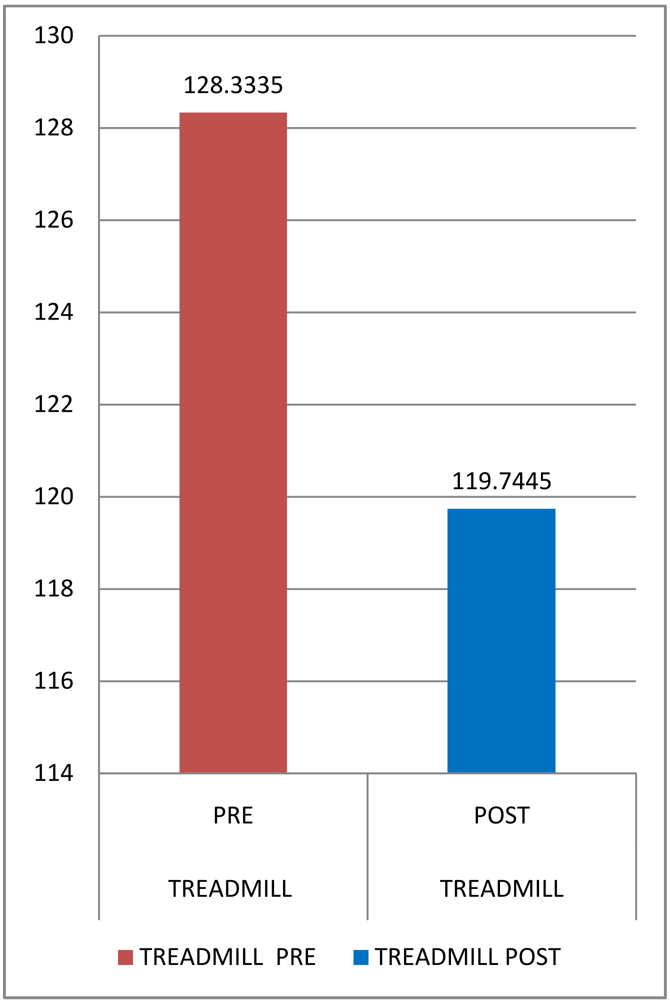
Total cholesterol of tread Mill group (n=20), pre test (base line) Mean ± SD showed 184.263 ± 21.99 and post test mean, Mean ± SD showed 177.297 ± 22.42 with P value of 0.000 (P<0.05), which is a significant reduction in post test compared to pre test.(Fig. no: 12) (Table no: 2)

TOTAL CHOLESTEROL (Fig. no: 12)



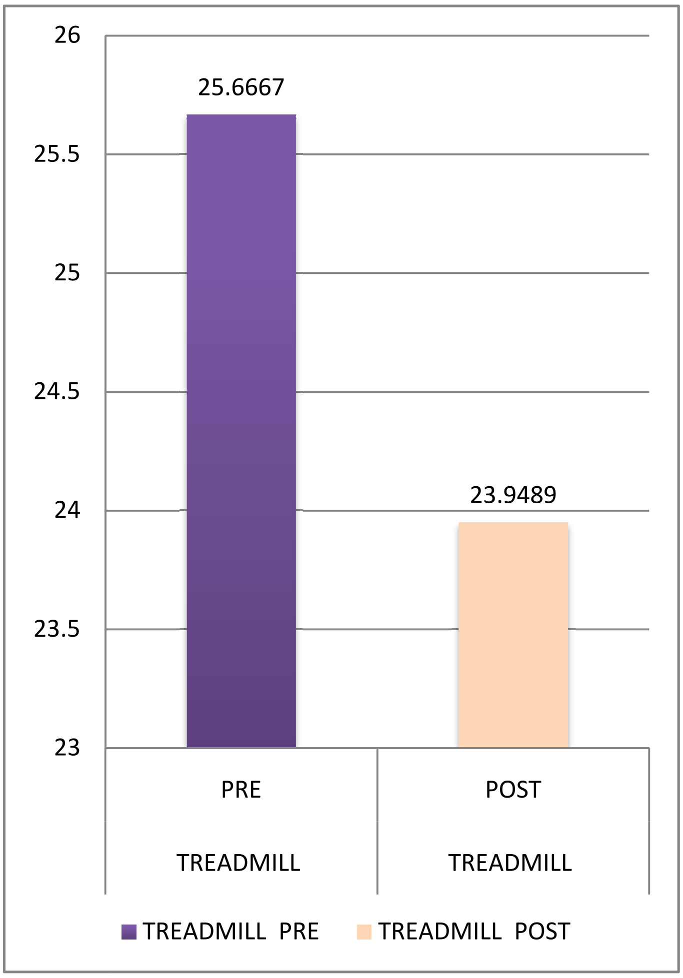
Triglycerides of treadmill group (n=20), pre test (baseline) Mean ± SD showed 128.333 ± 16.39 and post test Mean ± SD showed 119.744 ± 18.47; P value 0.003 ($P<0.05$), which is a significant reduction in post test compared to pre test. (Fig. no: 13) (Table no: 2)

TRIGLYCERIDES (Fig. no: 13)



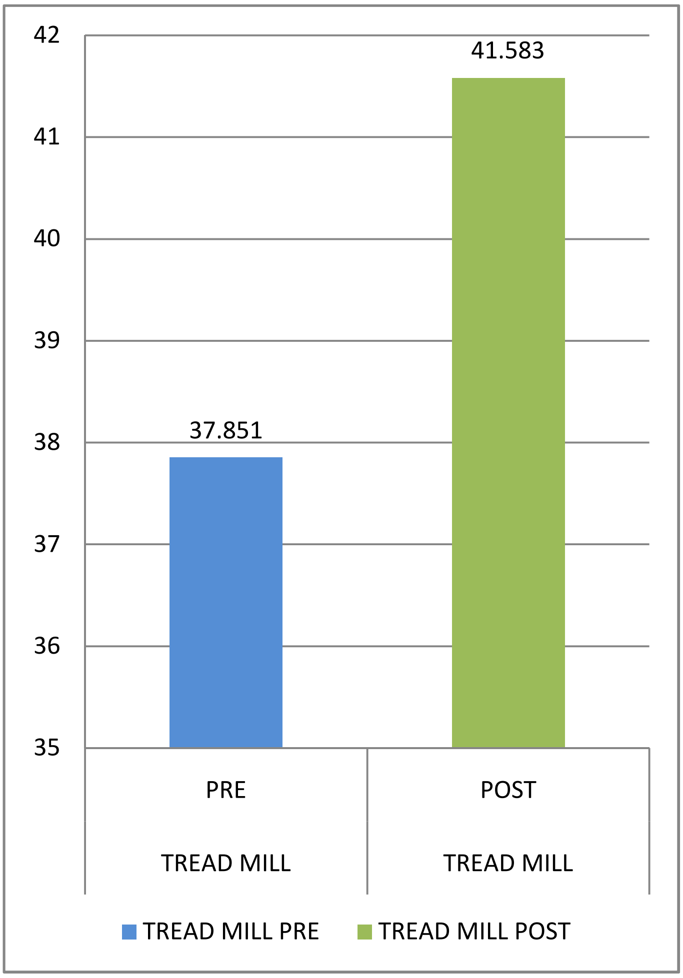
Very Low Density Lipoprotein of treadmill group (n=20), pre test (baseline) Mean ± SD showed 25.666 ± 3.28, post test Mean ± SD showed 23.948 ± 3.69; P value of 0.000 ($P<0.05$), which is a significant reduction in post test compared to pre test. (Fig. no: 14) (Table no: 2)

VERY LOW DENSITY LIPOPROTEIN (Fig. no: 14)



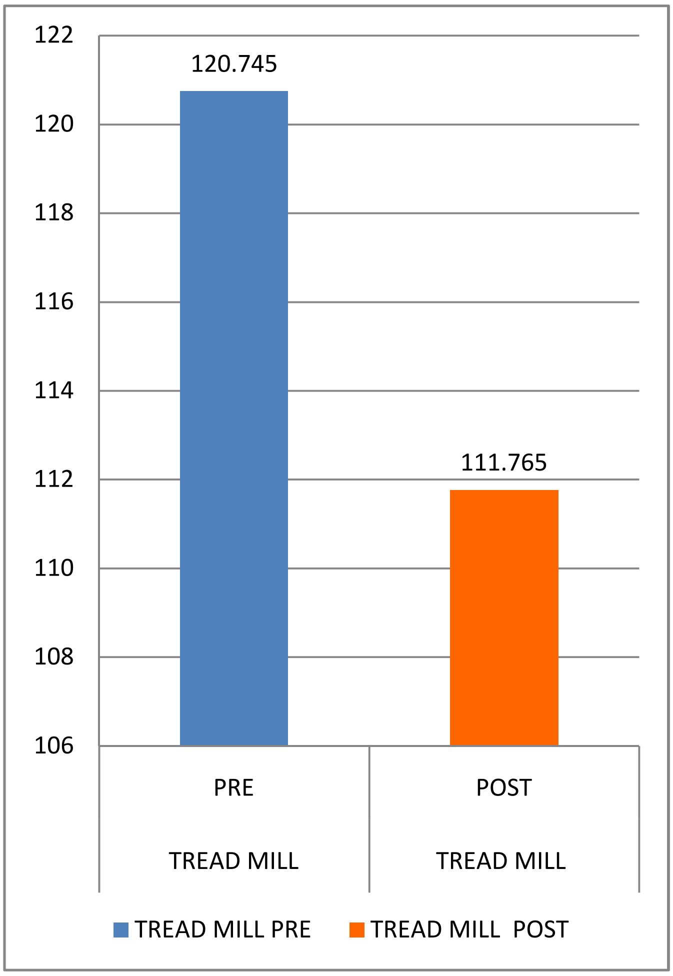
High Density Lipoprotein of treadmill group (n=20), pre test Mean ± SD showed 37.851 ± 4.59 and post test Mean ± SD showed 41.583 ± 4.673; P value of 0.000 ($P<0.05$), which is a significant elevation in post test compared to pre test (Fig. no: 15) (Table no: 2)

HIGH DENSITY LIPOPROTEIN (Fig. no: 15)



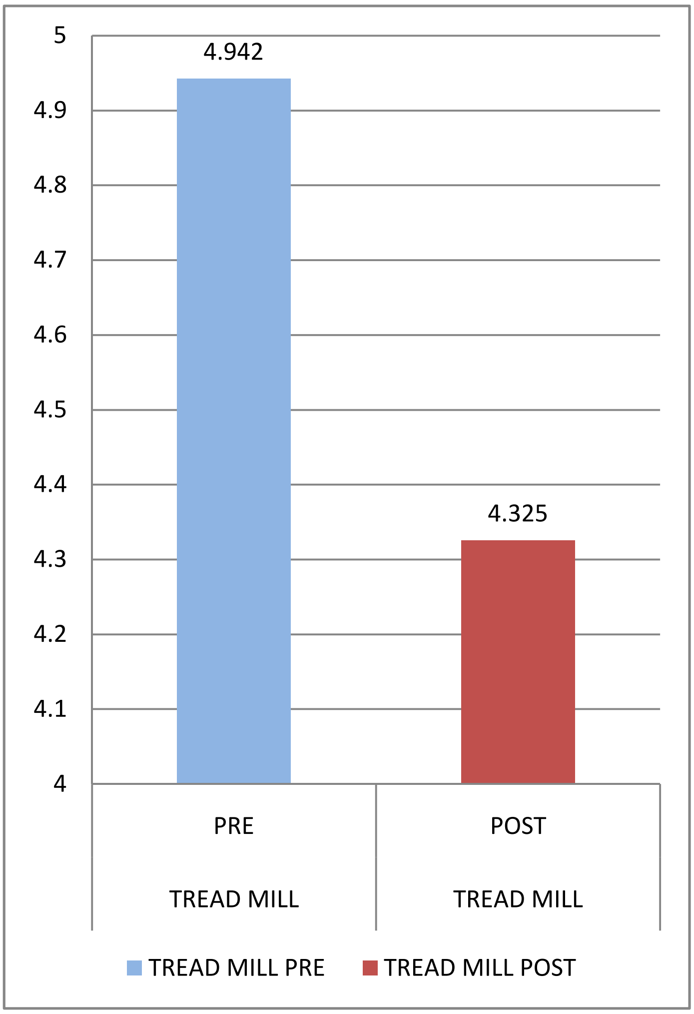
Low Density Lipoprotein of treadmill group (n=20), pre test Mean ± SD showed 120.745 ± 21.374, post test Mean ± SD showed 111.765 ± 21.73; P value of 0.000 (P<0.05), which is a significant reduction in post test. (Fig. No: 16) (Table no: 2)

LOW DENSITY LIPOPROTEIN (Fig no: 16)



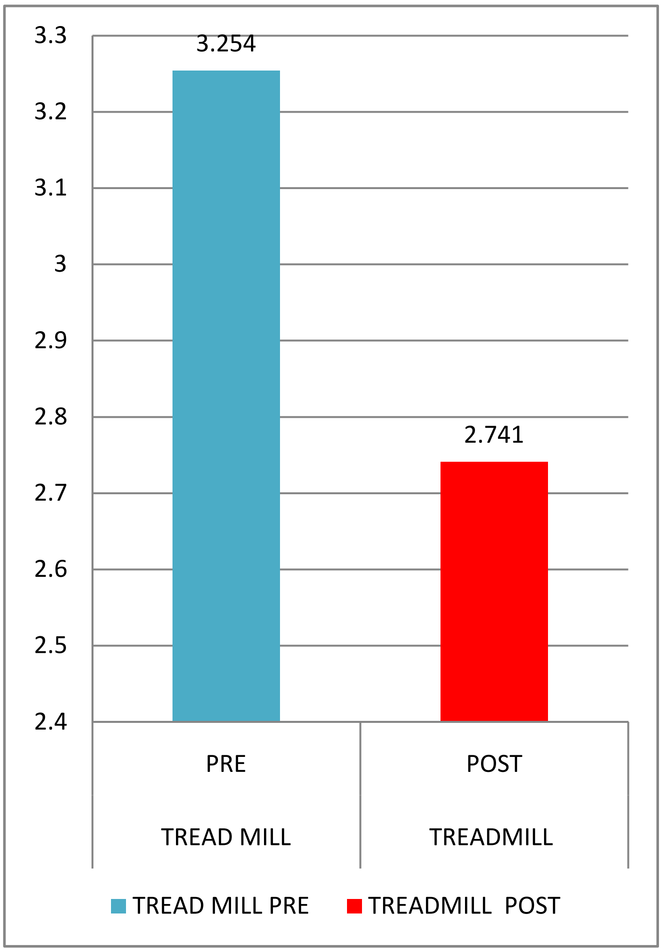
Total cholesterol / High Density Lipoprotein ratio of treadmill group (n=20), pre test Mean ± SD showed 4.942 ± 0.891 , post test showed Mean ± SD is 4.325 ± 0.814 ; P value 0.000 ($P<0.05$), which is a significant reduction in post test compared to pre test (Fig. No: 17) (Table no: 2)

TOTAL CHOLESTEROL / HIGH DENSITY LIPOPROTEIN RATIO (Fig. no: 17)



Low density Lipoprotein/High Density Lipoprotein of treadmill group (n=20), Mean ± SD of pre test showed 3.254 ± 0.799, post test showed 2.741 ± 0.723; P value of 0.000 (P<0.05), which is a significant reduction in post test result compared to pre test. (Fig. no: 18) (Table no: 2)

LOW DENSITY LIPOPROTEIN / HIGH DENSITY LIPOPROTEIN (Fig no: 18)



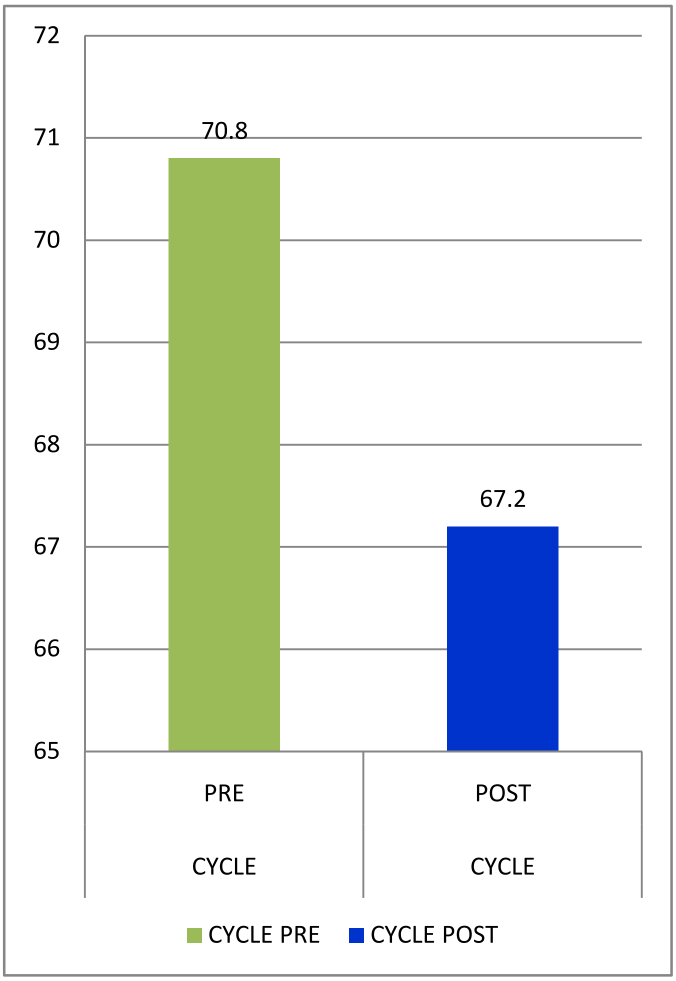
COMPARISON OF VARIABLES IN PRE TEST AND POST TEST IN CYCLE

(GROUP C) (Table no: 3)

Variable	Group C	Test type	n	Mean ± SD	P value
Weight	Cycle	Pre test	20	70.8 ± 15.343	0.000
		Post test	20	67.2 ± 13.968	
BMI	Cycle	Pre test	20	27.111 ± 5.110	0.000
		Post test	20	25.750 ± 4.726	
TC	Cycle	Pre test	20	180.42 ± 20.249	0.000
		Post test	20	174.19 ± 19.193	
TGL	Cycle	Pre test	20	129.93 ± 12.809	0.000
		Post test	20	121.99 ± 12.591	
VLDL	Cycle	Pre test	20	25.98 ± 2.583	0.000
		Post test	20	24.39 ± 2.518	
HDL	Cycle	Pre test	20	37.14 ± 4.043	0.000
		Post test	20	40.72 ± 4.483	
LDL	Cycle	Pre test	20	117.29 ± 20.434	0.000
		Post test	20	109.06 ± 19.230	
TC/HDL	Cycle	Pre test	20	4.902 ± 0.7002	0.000
		Post test	20	4.314 ± 0.5799	
LDL/HDL	Cycle	Pre test	20	3.198 ± 0.664	0.000
		Post test	20	2.710 ± 0.554	

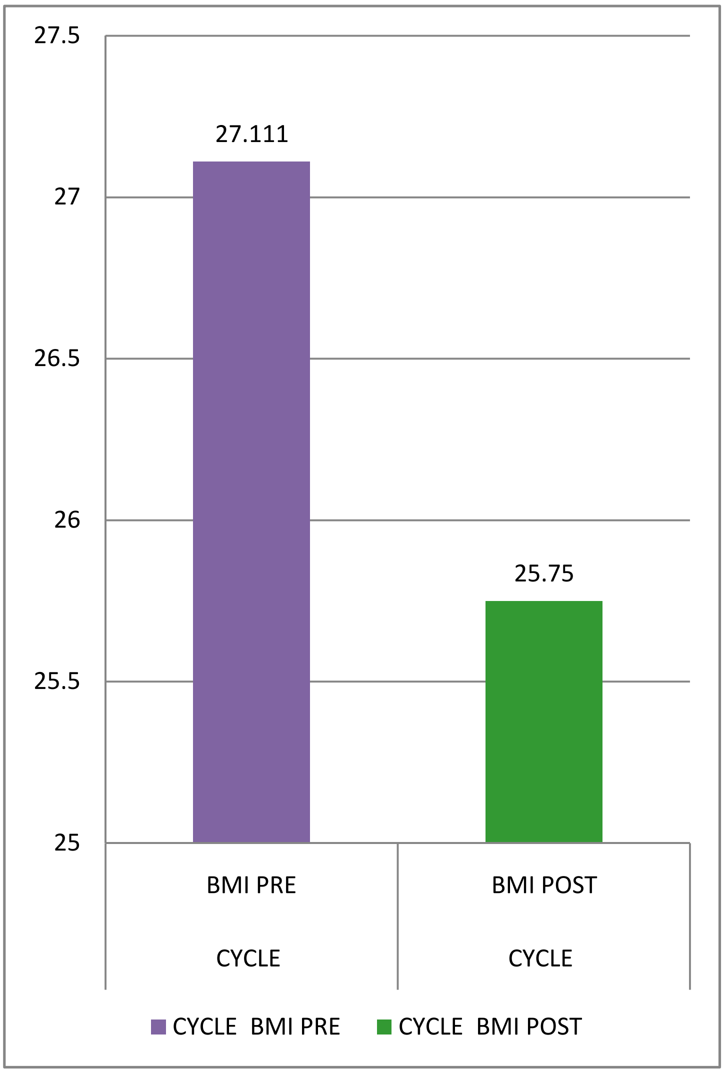
Weight of cycle group (n=20), pre test Mean ± SD showed 70.8 ± 15.343 and post test Mean ± SD showed 67.2 ± 13.968 with P value of 0.000 ($P<0.05$), which is a significant reduction in post test compared to pre test. (Fig. no: 19) (Table no: 3)

WEIGHT (Fig no: 19)



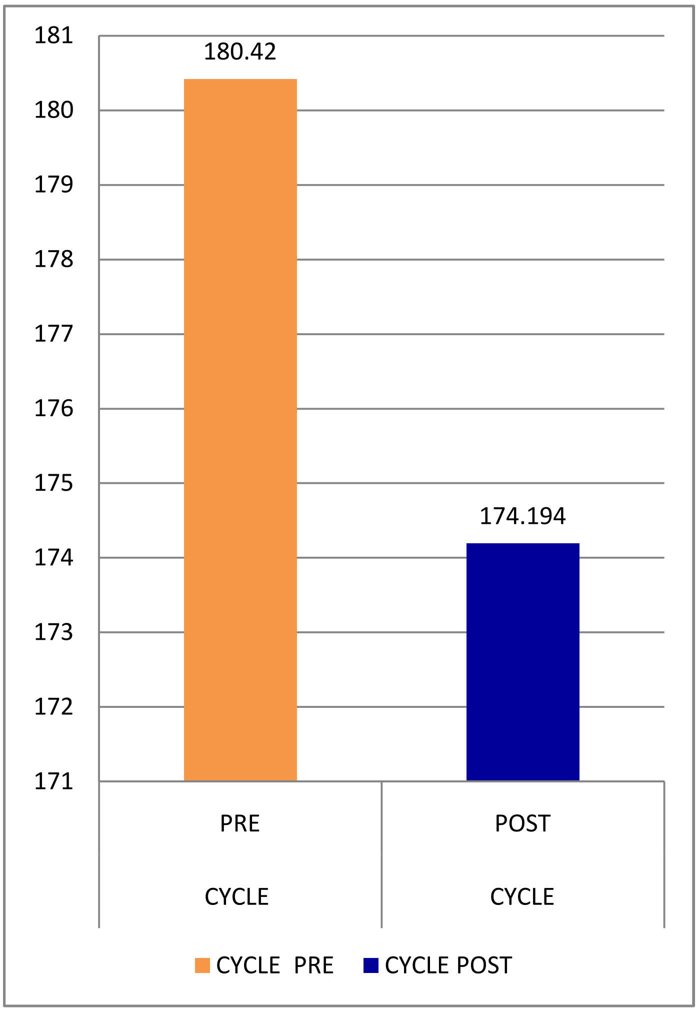
Body Mass Index of cycle group (n=20), pre test Mean ± SD showed 27.111 ± 5.11 and post test Mean ± SD showed 25.75 ± 4.726; P value of 0.000 (P<0.05), which is a significant reduction in post test compared to pre test. (Fig. no: 20) (Table no: 3)

BODY MASS INDEX (Fig. no: 20)



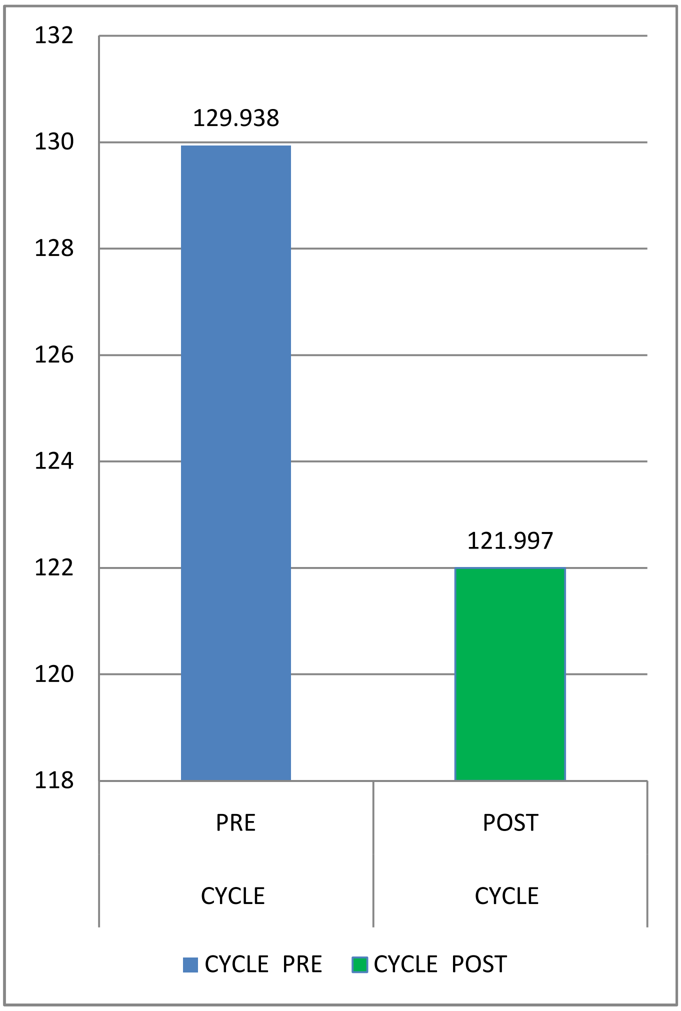
Total cholesterol of cycle group (n=20), pre test Mean ± SD showed 180.42 ± 20.24 and post test Mean ± SD showed 174.194 ± 19.19; P value of 0.000 (P<0.05), which is a significant reduction in post test compared to pre test. (Fig no: 21) (Table no: 3)

TOTAL CHOLESTEROL (Fig. no: 21)



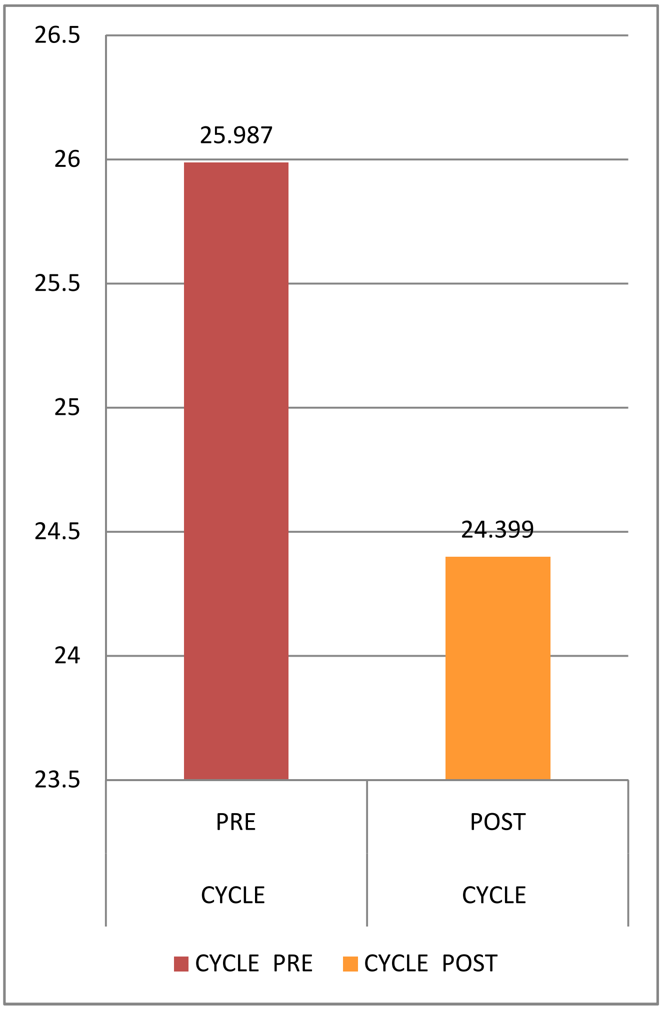
Triglycerides of cycle group (n=20), pre test Mean ± SD showed 129.938 ± 12.809 and post Mean ± SD showed 121.997 ± 12.591; P value of 0.000 ($P<0.05$) which is a significant reduction in post test compared to pre test. (Fig. no: 22) (Table no: 3)

TRIGLYCERIDES (Fig. no: 22)



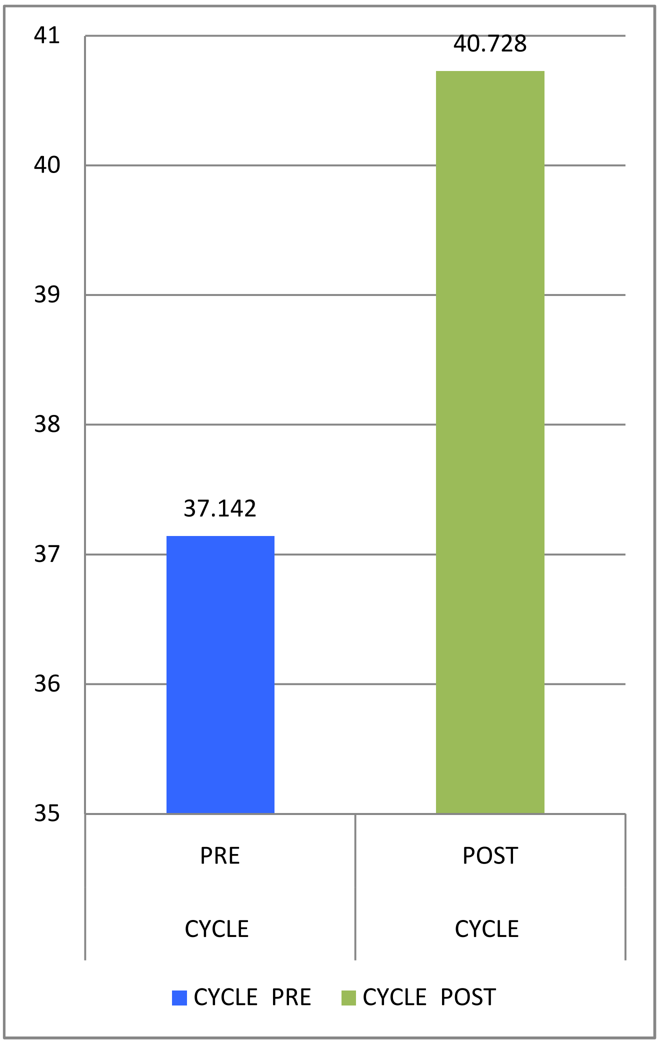
Very Low Density Lipoprotein of cycle group (n=20), pre test Mean ± SD showed 25.987 ± 2.583 , post test Mean ± SD showed 24.399 ± 2.51; P value of 0.000 ($P<0.05$) which is a significant reduction on post test compared to pre test. (Fig. no: 23) (Table no: 3)

VERY LOW DENSITY LIPOPROTEIN (Fig. no: 23)



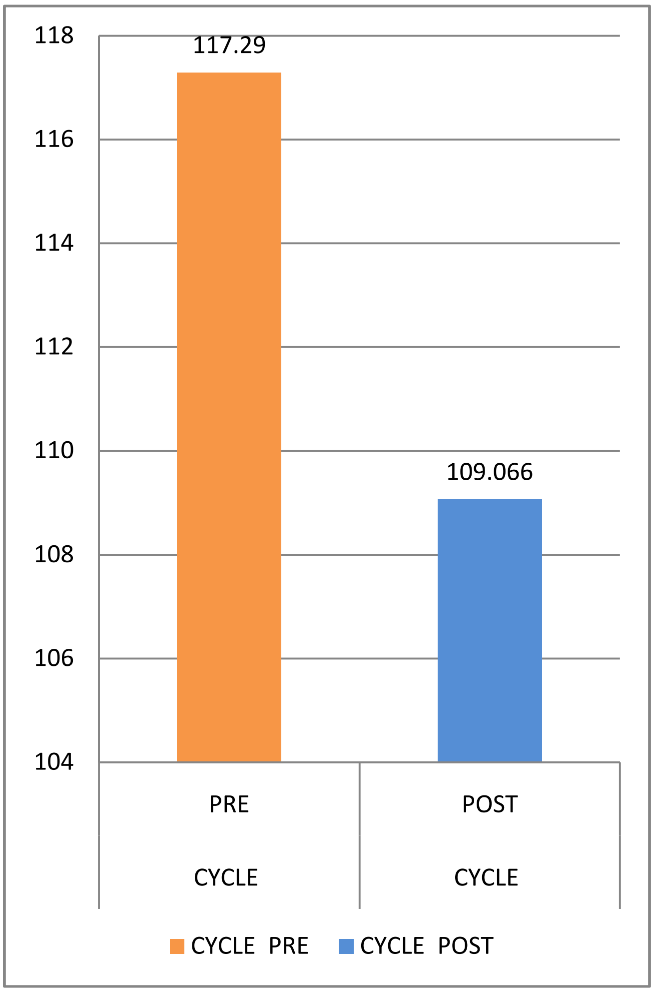
High Density Lipoprotein of cycle group (n=20), pre test Mean ± SD showed 37.142 ± 4.04 and post test Mean ± SD showed 40.728 ± 4.48; P value of 0.000 ($P<0.05$) which is a significant elevation in post test compared to pre test. (Fig. no: 24) (Table no: 3)

HIGH DENSITY LIPOPROTEIN (Fig. no: 24)



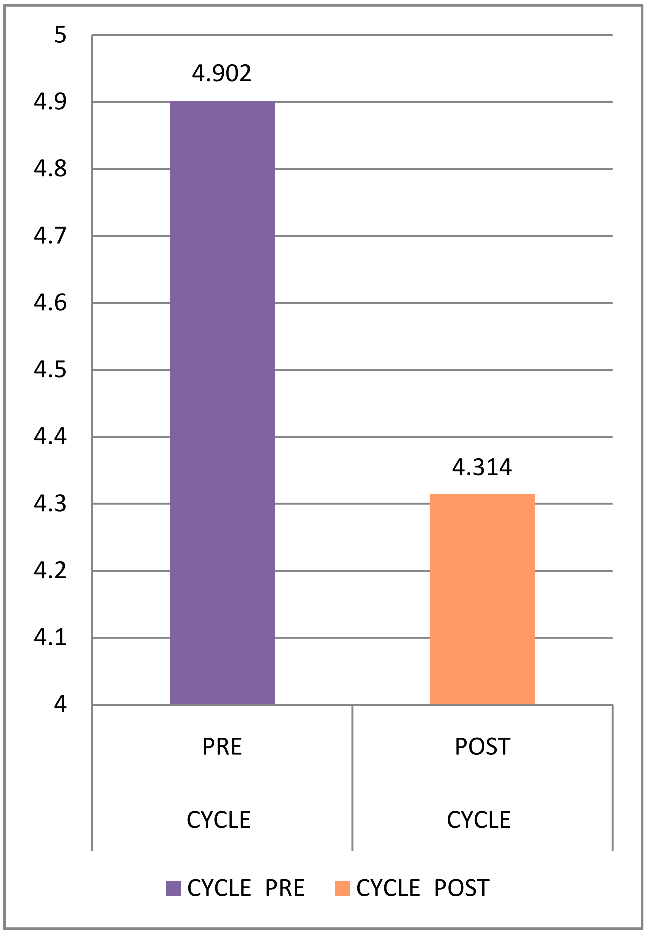
Low Density Lipoprotein, pre test Mean ± SD showed 117.29 ± 20.432 , post test Mean ± SD showed 109.066 ± 19.23; P value of 0.000 (P<0.05) which is a significant reduction in post test compared to pre test. (Fig. no: 25) (Table no: 3)

LOW DENSITY LIPOPROTEIN (Fig. no: 25)



Total cholesterol/High Density Lipoprotein ratio of cycle group (n=20), pre test Mean ± SD showed 4.902 ± 0.7002 , post test Mean ± SD showed 4.314 ± 0.5799; P value of 0.000 ($P<0.05$) which is a significant reduction in post test results compared to pre test. (Fig. no: 26) (Table no: 3)

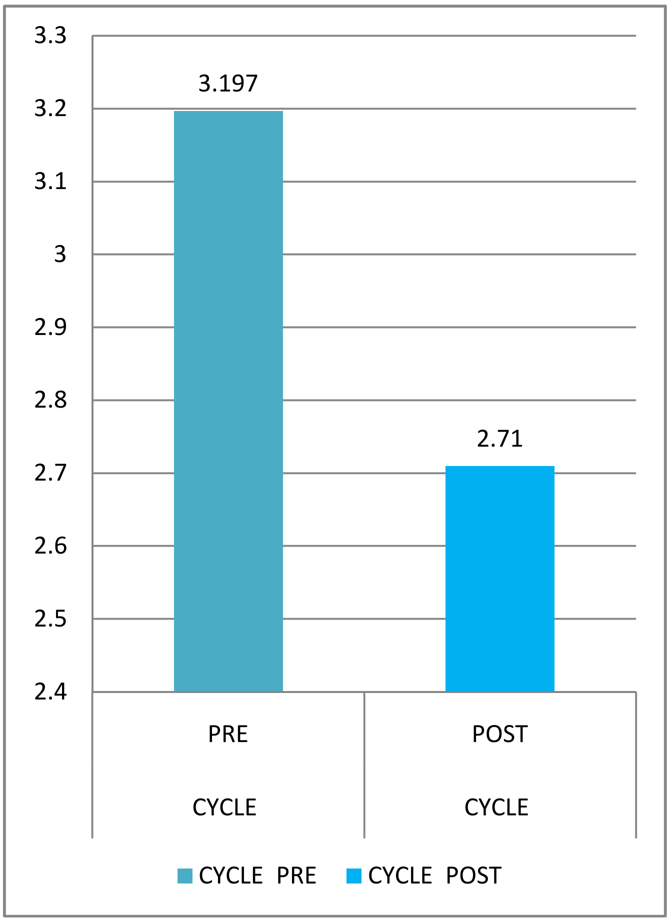
TOTAL CHOLESTEROL / HIGH DENSITY LIPOPROTEIN RATIO (Fig. no: 26)



Low density Lipoprotein/High Density Lipoprotein ratio Mean ± SD of pre test showed 3.198 ± 0.664, post test of Mean ± SD showed 2.710 ± 0.554; P value of 0.000 ($P<0.05$) which is a significant reduction in post test compared to pre test.(Fig. no: 27) (Table no: 3)

LOW DENSITY LIPOPROTEIN / HIGH DENSITY LIPOPROTEIN RATIO

(Fig. no: 27)



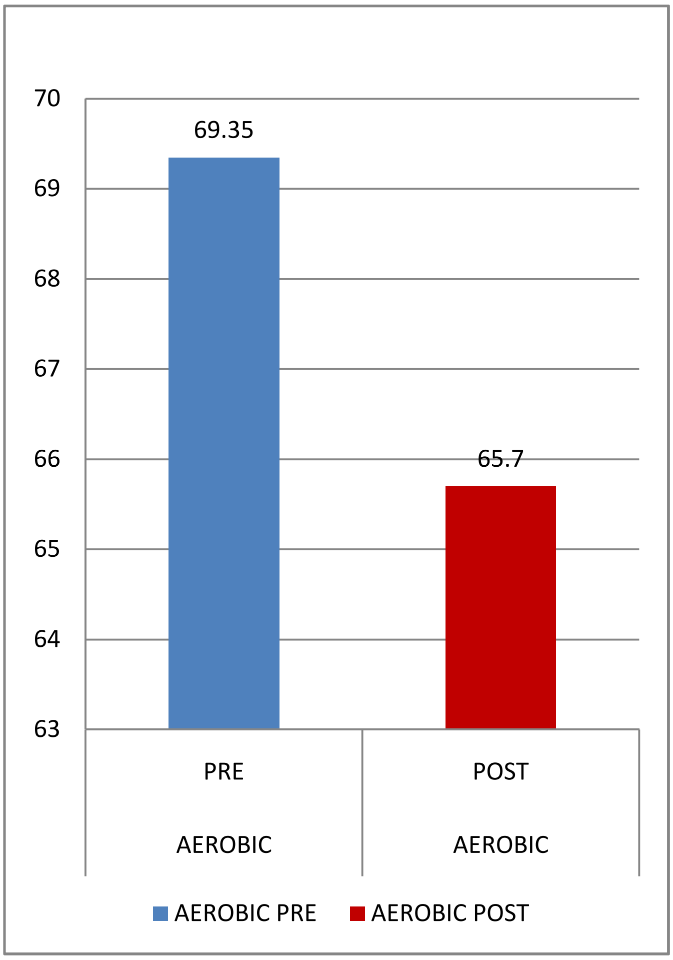
COMPARISON OF PRE TEST AND POST TEST AEROBIC TRAINING GROUP B + C (TREAD MILL + CYCLE) (Table no: 4)

Variable	Group B + C	Test type	n	Mean ± SD	P value
Weight	Aerobic	Pre test	40	69.35 ± 14.534	0.000
		Post Test	40	65.7 ± 12.928	
BMI	Aerobic	Pre Test	40	26.569 ± 5.035	0.000
		Post Test	40	25.18 ± 4.480	
TC	Aerobic	Pre test	40	182.341 ±20.958	0.000
		Post test	40	175.745 ± 20.663	
TGL	Aerobic	Pre test	40	129.136 ±14.543	0.003
		Post test	40	120.870 ± 15.649	
VLDL	Aerobic	Pre test	40	25.825 ± 2.910	0.000
		Post test	40	24.174 ± 2.51	
HDL	Aerobic	Pre test	40	37.496 ± 4.288	0.000
		Post test	40	41.155 ± 4.541	
LDL	Aerobic	Pre test	40	119.017 ± 20.713	0.000
		Post test	40	110.415 ± 20.303	
TC/HDL	Aerobic	Pre test	40	4.922 ± 0.791	0.000
		Post test	40	4.320 ± 0.697	
LDL/HDL	Aerobic	Pre test	40	3.225 ± 0.726	0.000
		Post test	40	2.725 ± 0.636	

To compare the aerobic exercise group (n= 40), merging of treadmill and cycle groups were done [Tread mill (n=20) and Cycle group (n = 20)]

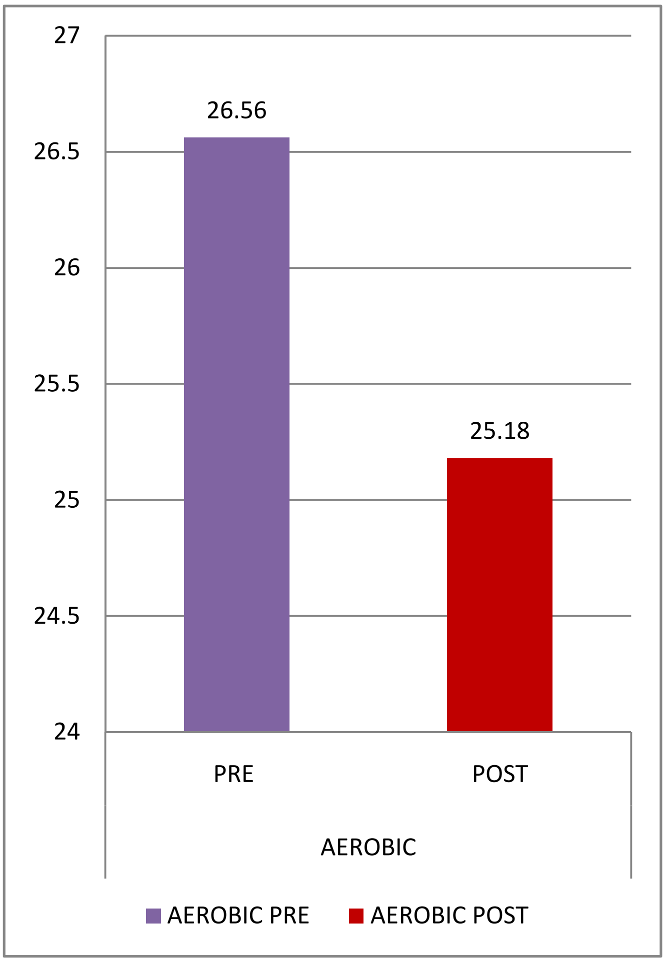
Weight of aerobic group (n=40), pre test Mean ± SD showed 69.35 ± 14.534 and post test Mean ± SD showed 65.7 ± 12.928 with P value of 0.000 ($P<0.05$), which is a significant reduction in post test result compared to baseline results (pre test) (Fig. no: 28) (Table no: 4)

WEIGHT (Fig. no: 28)



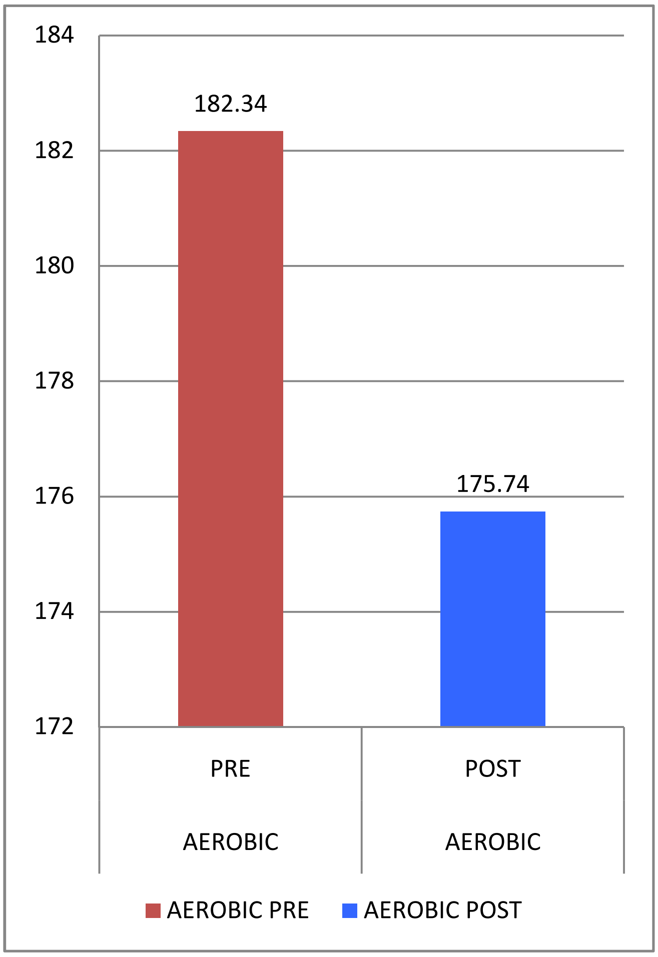
Body Mass Index of aerobic group (n=40), pre test Mean ± SD showed 26.569 ± 5.035and post test Mean ± SD showed 25.18 ± 4.480; P value of 0.000 (P<0.05), which is a significant reduction in post test compared to pre test. (Fig. no: 29) (Table no: 4)

BODY MASS INDEX (Fig. no: 29)



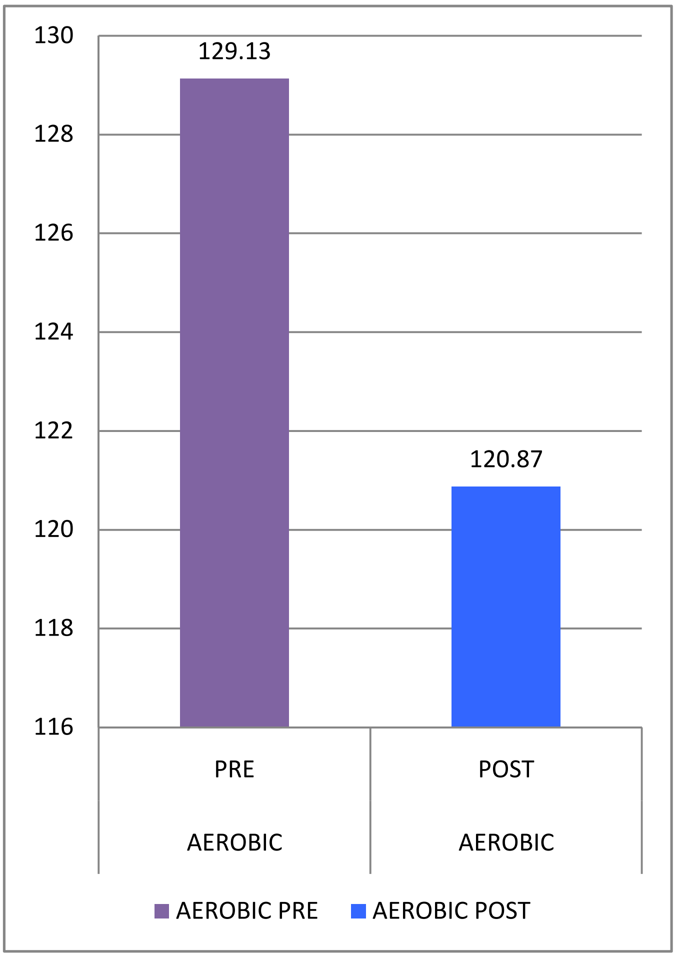
Total cholesterol of aerobic group (n=40), pre test Mean ± SD showed 182.341 ± 20.958 and post test Mean ± SD showed 175.745 ± 20.663; P value of 0.000 ($P<0.05$), which is a significant reduction in post test results compared to pre test result.(Fig. no: 30) (Table no: 4)

TOTAL CHOLESTEROL (Fig. No: 30)



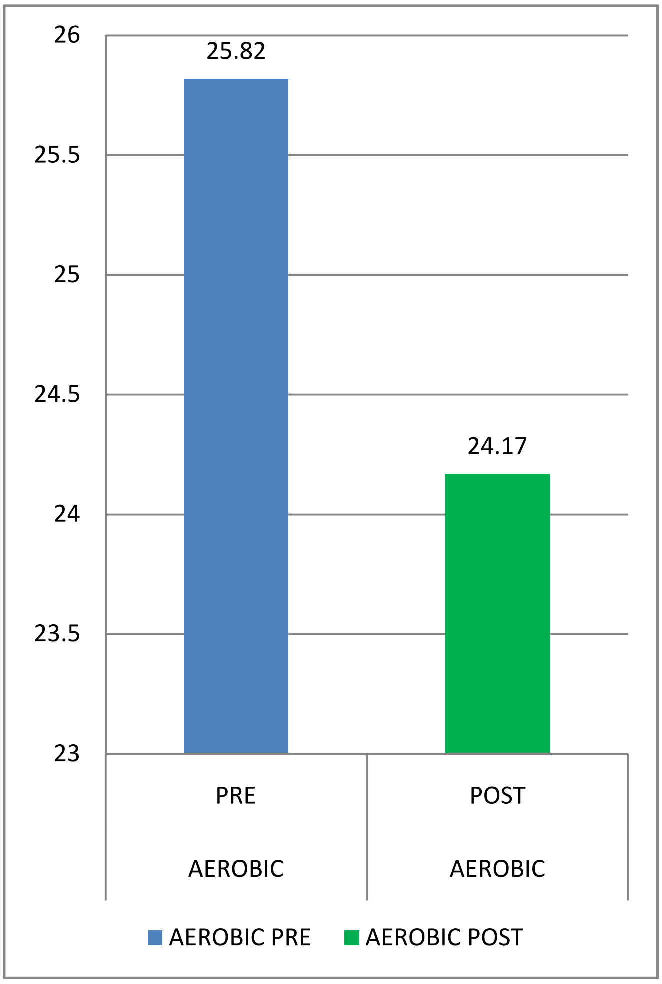
Triglycerides of aerobic group (n=40), pre test Mean ± SD showed 129.136 ± 14.543 and post Mean ± SD showed 120.870 ± 15.649; P value of 0.003 ($P<0.05$), which is a significant reduction in post test compared to pre test. (Fig. no: 31) (Table no: 4)

TRIGLYCERIDES (Fig. no: 31)



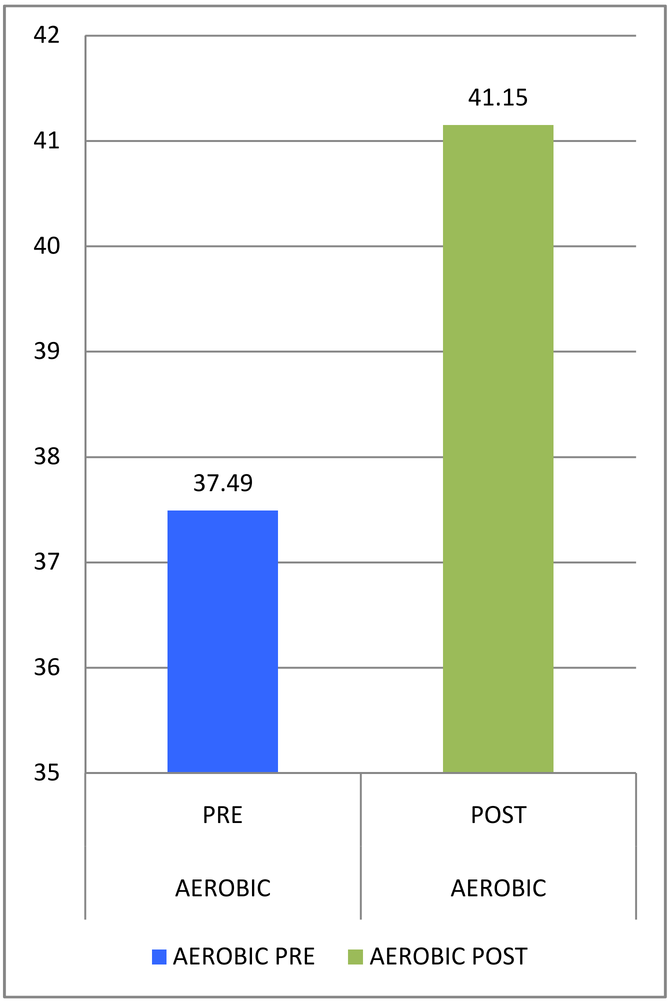
Very Low Density Lipoprotein of aerobic group (n=40), pre test Mean ± SD showed 25.825 ± 2.910 , post test Mean ± SD showed 24.174 ± 2.51; P value of 0.000($P<0.05$) which is a significant reduction in post test compared to pre test. (Fig no: 32) (Table no: 4)

VERY LOW DENSITY LIPOPROTEIN (Fig. no: 32)



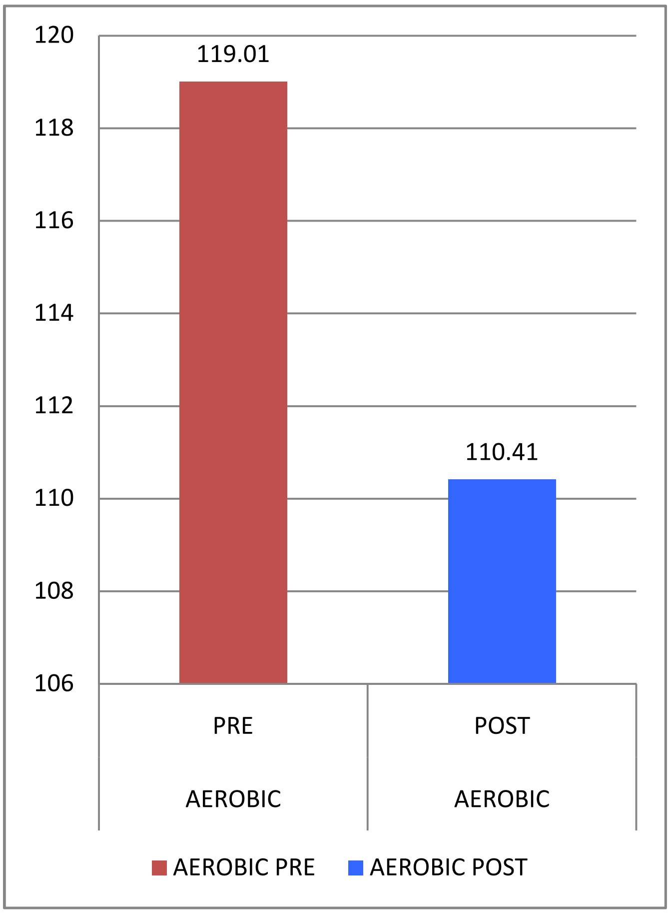
High Density Lipoprotein of aerobic group (n=40), Pre test Mean ± SD showed 37.496 ± 4.288 and post test Mean ± SD showed 41.155 ± 4.541; P value of 0.000 ($P<0.05$) which is a significant elevation in post test compared to pre test. (Fig. no: 33) (Table no: 4)

HIGH DENSITY LIPOPROTEIN (Fig. no: 33)



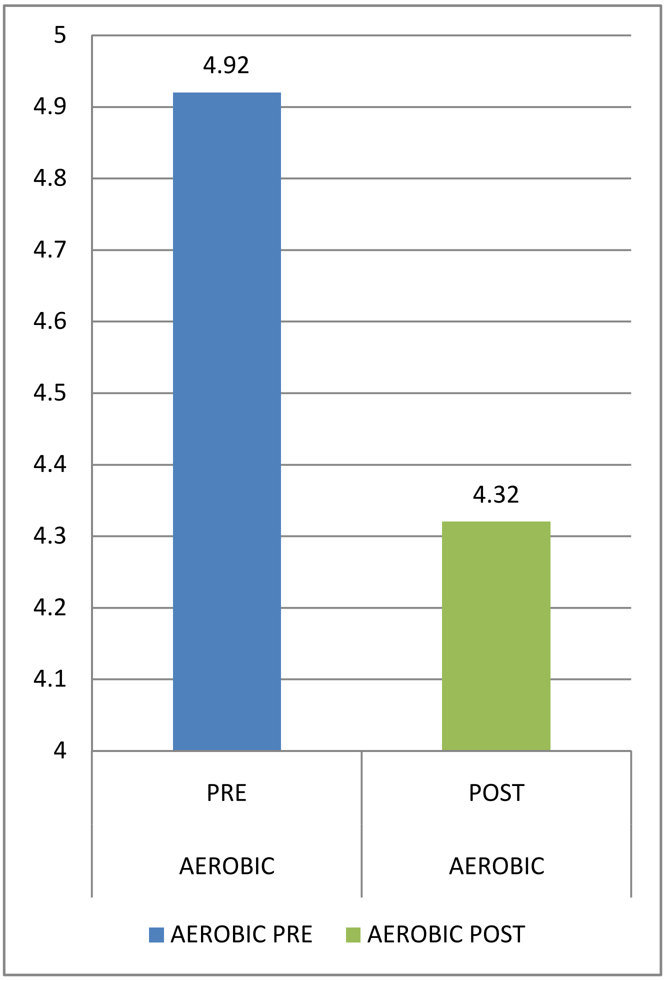
Low Density Lipoprotein of aerobic group (n=40), pre test Mean ± SD showed 119.017 ± 20.713, post test Mean ± SD showed 110.415 ± 20.303; P value of 0.000 ($P<0.05$) which is a significant reduction in post test compared to pre test. (Fig. no: 34) (Table no: 4)

LOW DENSITY LIPOPROTEIN (Fig. no: 34)



Total cholesterol/High Density Lipoprotein ratio of aerobic group(n=40), pre test Mean ± SD showed 4.922 ± 0.791, post test Mean ± SD showed 4.320 ± 0.697; P value of 0.000 ($P<0.05$), which is a significant reduction in post test result compared to pre test result (Fig. no: 35) (Table no: 4)

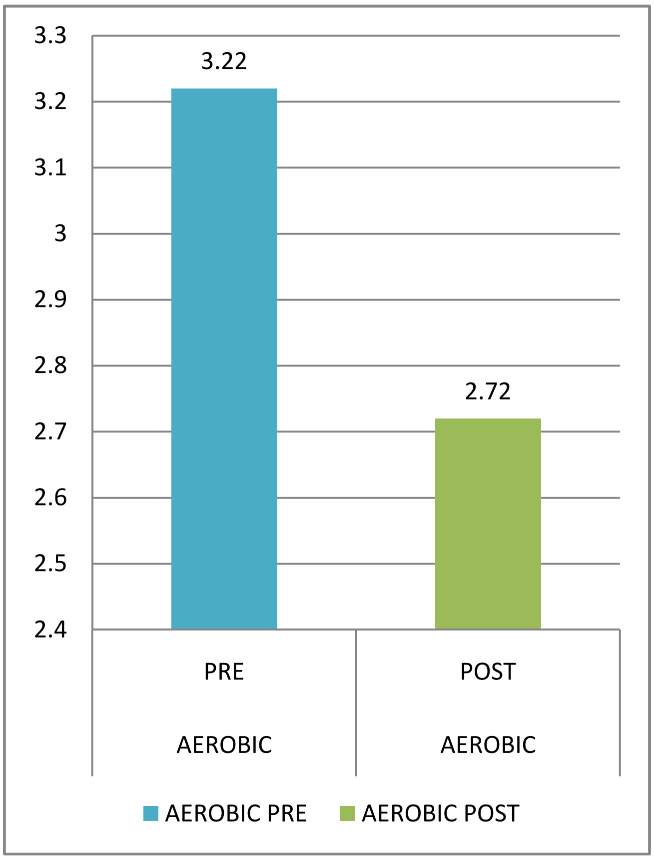
TOTAL CHOLESTEROL / HIGH DENSITY LIPOPROTEIN RATIO (Fig no: 35)



Low density Lipoprotein/High Density Lipoprotein ratio of aerobic group (n=40), Mean ± SD of pre test showed 3.225 ± 0.726, post test of Mean ± SD showed 2.725± 0.636; P value of 0.000 (P<0.05), which is a significant reduction in post test mean compared to pre test (Fig. no: 36) (Table no: 4)

LOW DENSITY LIPOPROTEIN / HIGH DENSITY LIPOPROTEIN RATIO

(Fig. no: 36)

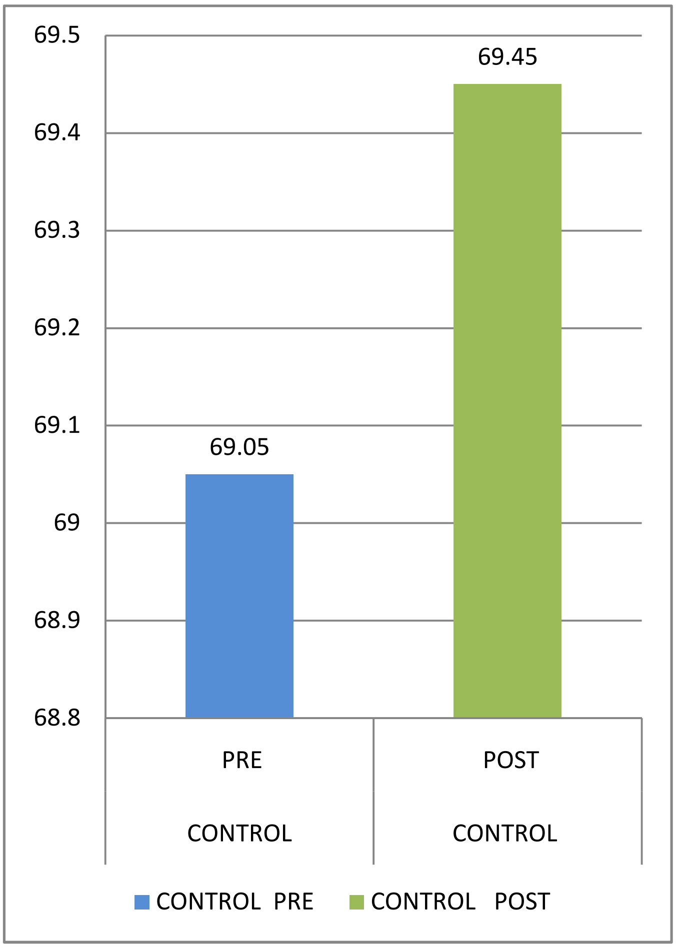


COMPARISON OF PRE-TEST AND POST-TEST OF CONTROL GROUP A
(Table no: 5)

Variable	**Group A**	**Test type**	**n**	**Mean ± SD**	**P value**
Weight	Control	Pre test	40	69.05 ± 8.629	0.0583
		Post Test	40	69.45 ± 8.442	
BMI	Control	Pre Test	40	26.312 ± 3.032	0.054
		Post Test	40	26.472 ± 3.0291	
TC	Control	Pre test	40	184.53 ± 18.316	0.307
		Post test	40	185.46 ± 16.585	
TGL	Control	Pre test	40	132.68 ± 23.191	0.476
		Post test	40	133.51 ± 21.764	
VLDL	Control	Pre test	40	26.53 ± 4.639	0.476
		Post test	40	26.70 ± 4.352	
HDL	Control	Pre test	40	37.26 ± 4.083	0.136
		Post test	40	36.97 ± 3.920	
LDL	Control	Pre test	40	120.72 ± 18.324	0.314
		Post test	40	121.78 ± 16.852	
TC/HDL	Control	Pre test	40	5.007 ± 0.731	0.132
		Post test	40	5.07 ± 0.719	
LDL/HDL	Control	Pre test	40	3.28 ± 0.661	0.156
		Post test	40	3.34 ± 0.655	

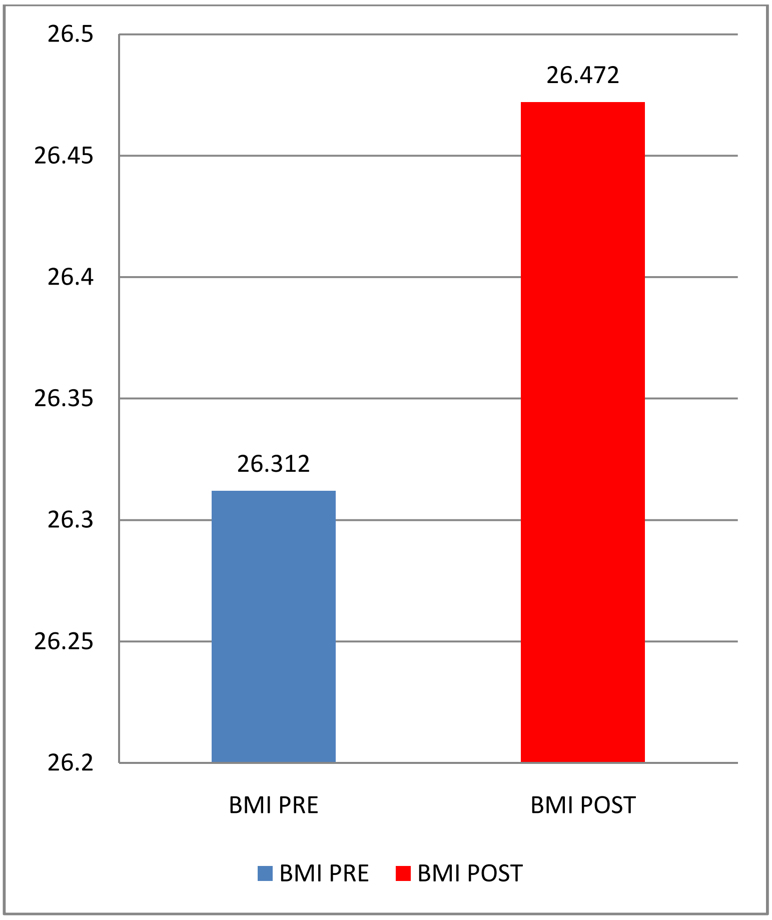
Weight of control group (n=40), pre test Mean ± SD showed 69.05 ± 8.629 and post test Mean ± SD showed 69.45 ± 8.442; P value of 0.058 (P>0.05), which is not a significant change between pre and post tests (Fig. no: 37) (Table no: 5)

WEIGHT (Fig. 37)



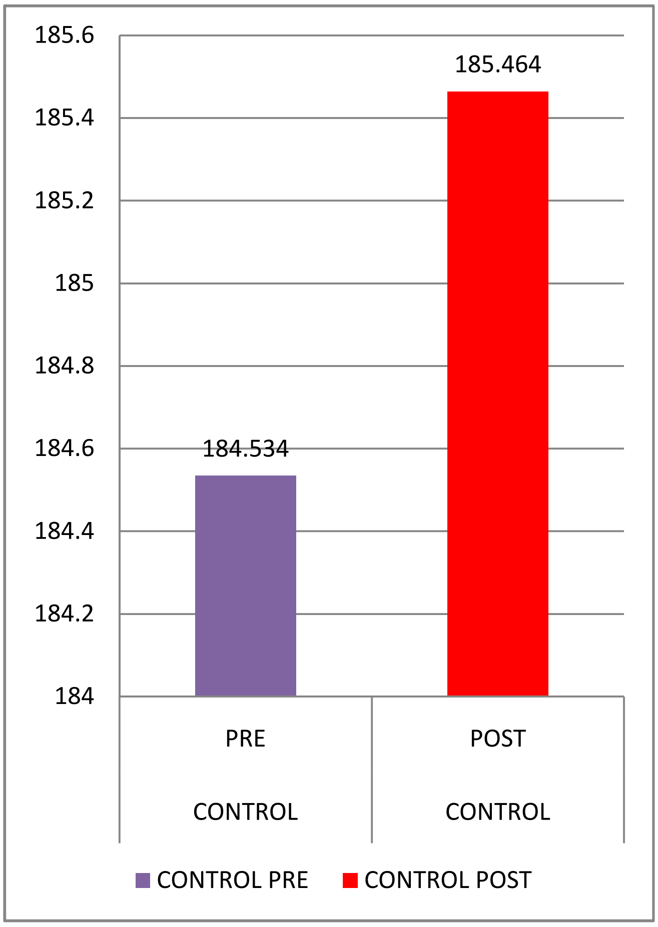
Body Mass Index of control group (n=40), pre test Mean ± SD showed 26.312 ± 3.032 and post test Mean ± SD showed 26.472 ± 3.029; P value of 0.054 (P>0.05), which is not a significant change between pre and post tests (Fig. no: 38) (Table no: 5)

BODY MASS INDEX (Fig. : 38)



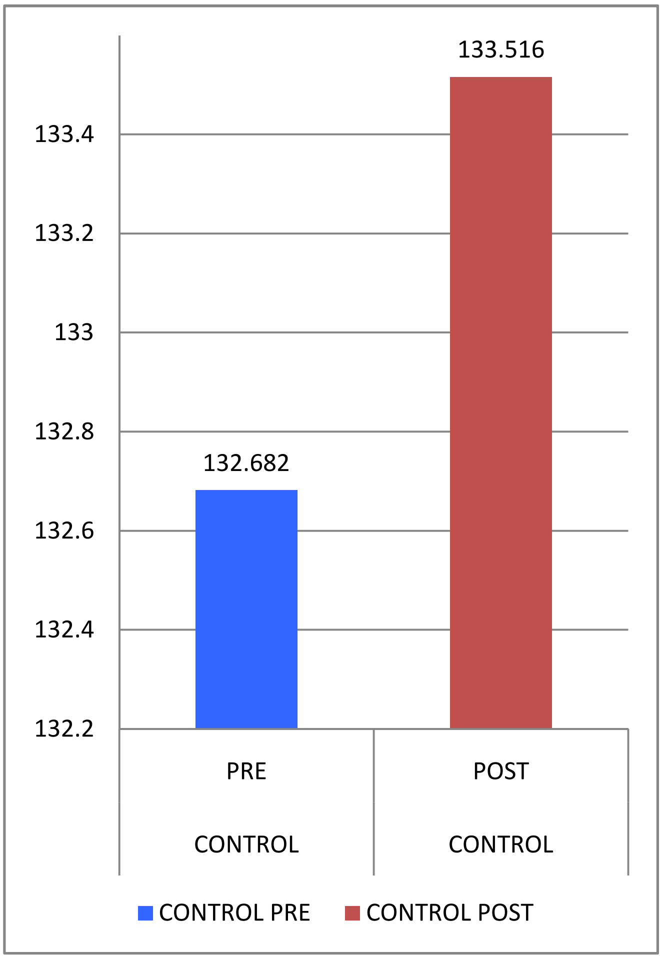
Total cholesterol of control group (n=40), pre test Mean ± SD showed 184.534 ± 18.31 and post test Mean ± SD showed 185.464 ± 16.585; P value of 0.307 (P>0.05), which is not a significant change between pre and post tests (Fig. no: 39) (Table no: 5)

TOTAL CHOLESTEROL (Fig. 39)



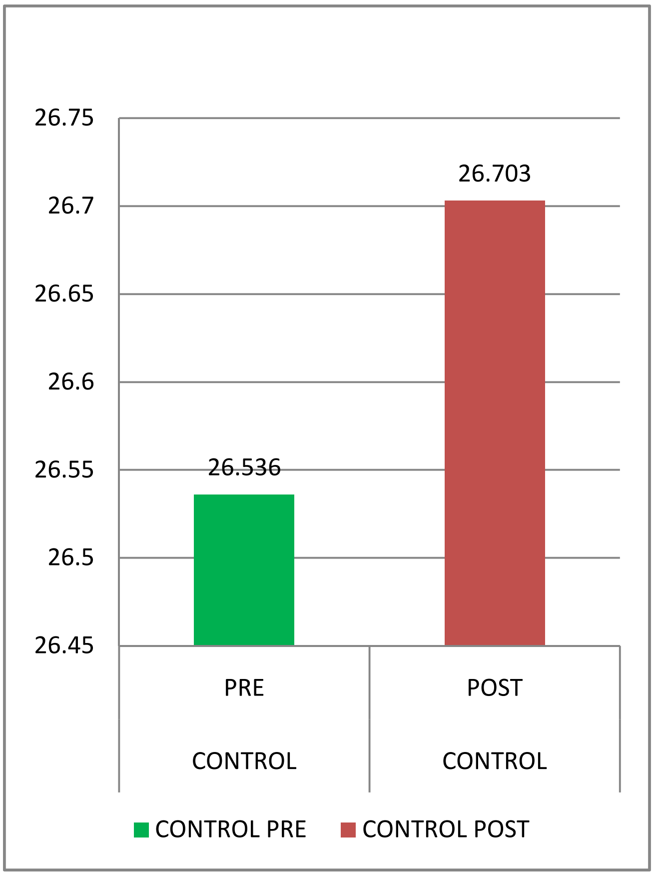
Triglycerides of control group (n=40), pre test Mean ± SD showed 132.682 ± 23.19 and post Mean ± SD showed 133.516 ± 21.764; P value of 0.476 (P>0.05), which is not a significant change between pre and post tests. (Fig. no: 40) (Table no: 5)

TRIGLYCERIDES (Fig. 40)



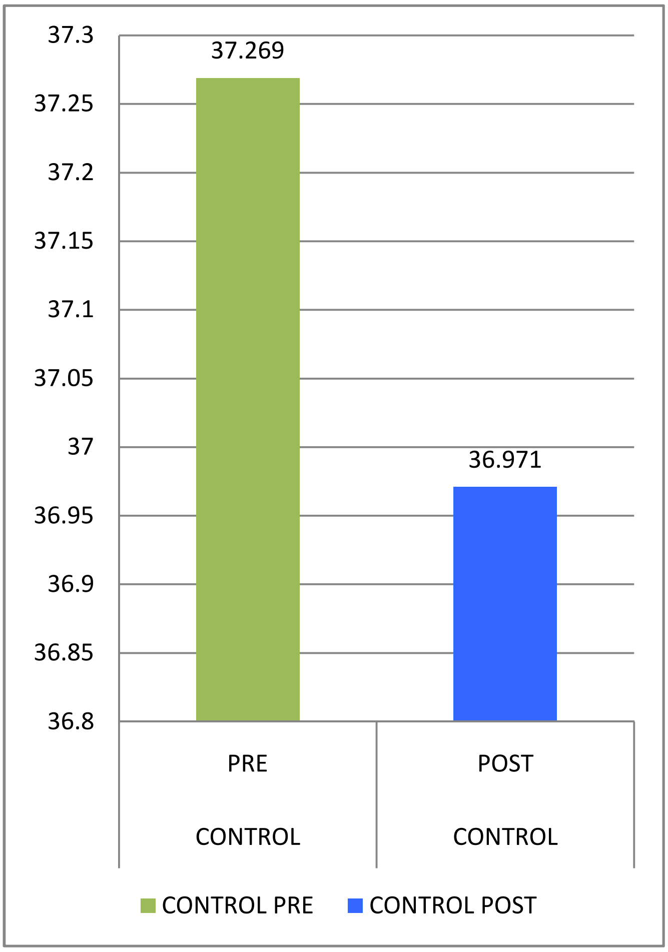
Very Low Density Lipoprotein of control group (n=40), pre test Mean ± SD showed 26.536 ± 4.639 , post test Mean ± SD showed 26.703 ± 4.352; P value of 0.476(P>0.05), which is not a significant change between pre and post tests. (Fig. no: 41) (Table no: 5)

VERY LOW DENSITY LIPOPROTEIN (Fig. 41)



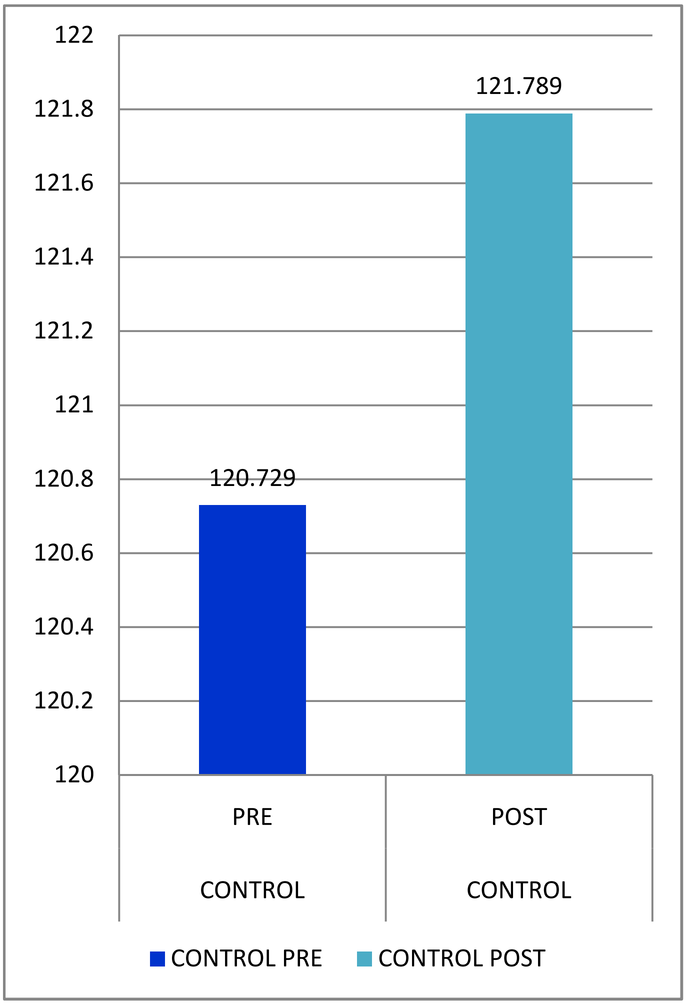
High Density Lipoprotein of control group (n=40), pre test Mean ± SD showed 37.269 ± 4.083 and post test Mean ± SD showed 36.971 ± 3.920; P value of 0.136 (P>0.05), which is not a significant change between pre and post tests. (Fig. No: 42) (Table no: 5)

HIGH DENSITY LIPOPROTEIN (Fig. 42)



Low Density Lipoprotein of control group (n=40), pre test Mean ± SD showed 120.729 ± 18.324, post test Mean ± SD showed 121.789 ± 16.852 with P value of 0.314 (P>0.05), which is not a significant change between pre and post tests. (Fig . No: 43) (Table no: 5)

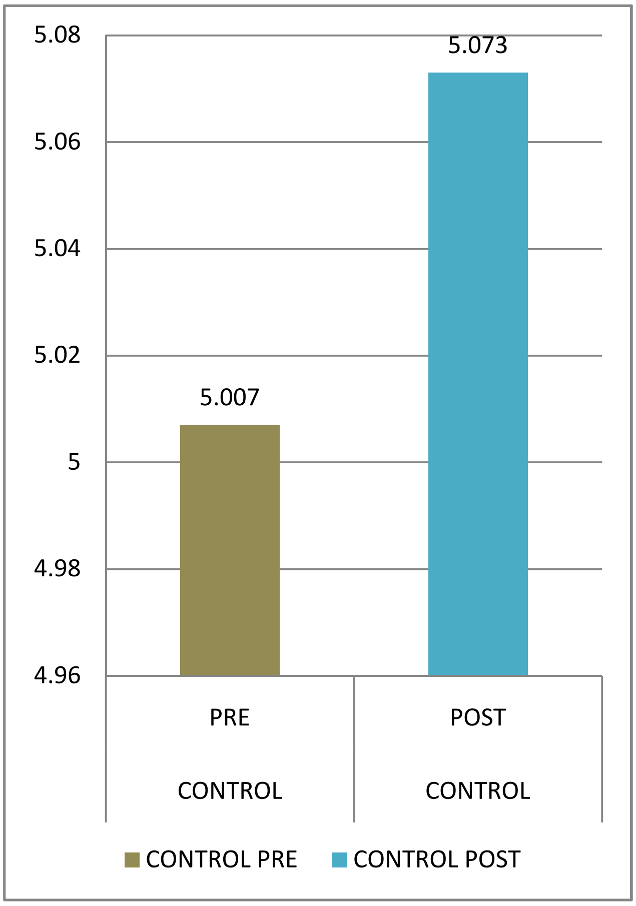
LOW DENSITY LIPOPROTEIN (Fig. 43)



Total cholesterol/High Density Lipoprotein ratio of control group (n=40), pre test Mean ± SD showed 5.007 ± 0.731, post test Mean ± SD showed 5.073 ±0.719 with P value of 0.132 (P>0.05), which is not a significant change between pre and post tests (Fig. no: 44) (Table no: 5)

TOTAL CHOLESTEROL / HIGH DENSITY LIPOPROTEIN RATIO

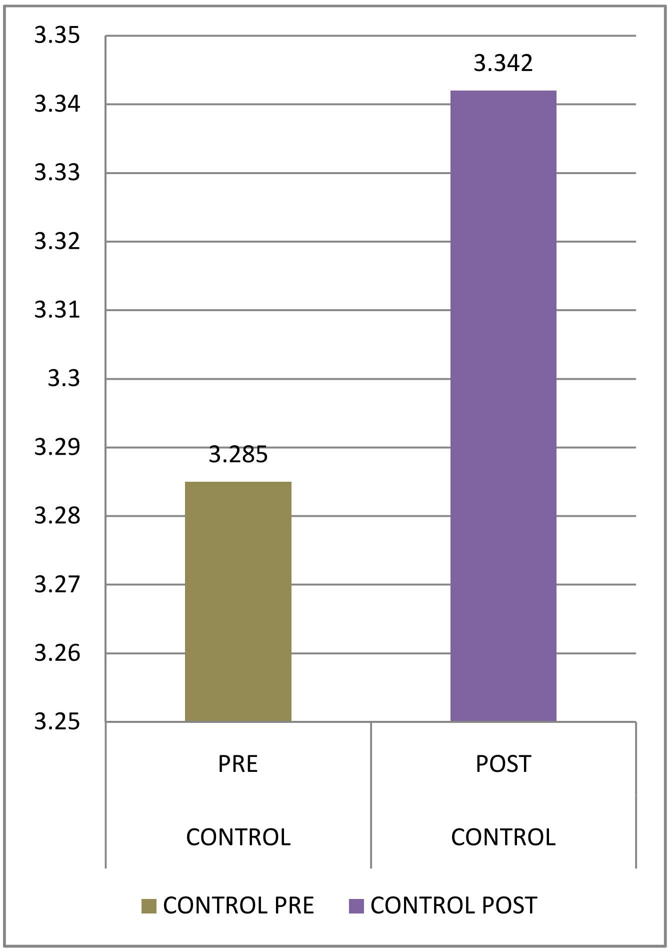
(Fig. 44)



Low density Lipoprotein/High Density Lipoprotein of control group (n=40), pre test Mean ± SD showed 3.284 ± 0.661, post test Mean ± SD showed 3.342 ± 0.655; P value of 0.156 (P>0.05), which is not a significant change between pre and post tests (Fig. no: 45) (Table no: 5)

LOW DENSITY LIPOPROTEIN / HIGH DENSITY LIPOPROTEIN

(Fig. 45)



COMPARISON OF MEAN DIFFERENCE BETWEEN PRE AND POST TESTS OF CONTROL (GROUP A), TREAD MILL (GROUP B) AND CYCLE (GROUP C)

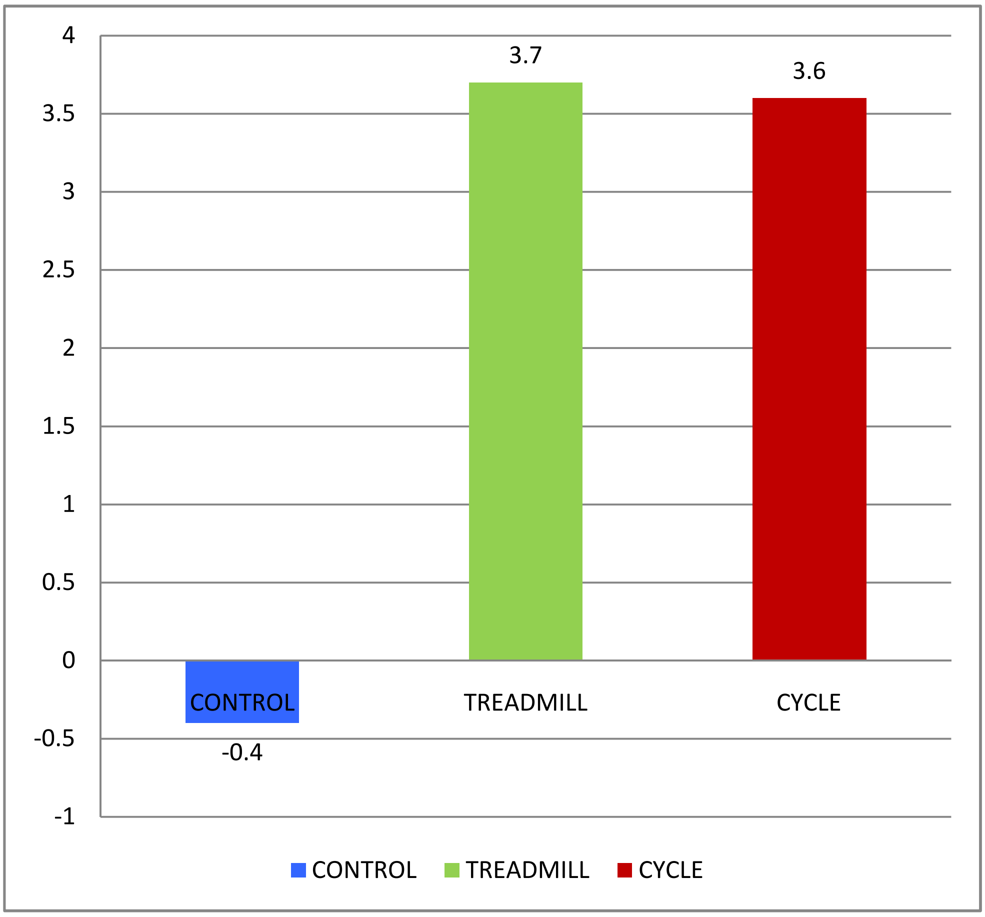
(Table no: 6)

VARIABLE	CONTROL GROUP A	TREAD MILL GROUP B	CYCLE GROUP C	INFERENCE (BEST)
Weight	-0.400 ± 1.296	3.700 ± 2.617	3.600 ± 2.1619	TREAD MILL
BMI	-0.163 ± 0.520	1.347 ± 0.747	1.430 ± 0.975	CYCLE
TC	-0.930 ± 5.679	6.966 ± 1.8200	6.226 ± 1.785	TREAD MILL
TGL	-0.834 ± 7.341	8.589 ± 11.596	7.941 ± 2.758	TREAD MILL
VLDL	-0.166 ± 1.468	1.715 ± 1.130	1.588 ± 0.551	TREAD MILL
HDL	0.297 ± 1.235	-3.732 ± 1.886	-3.585 ± 1.365	TREAD MILL
LDL	-1.060 ± 6.571	8.980 ± 3.230	8.223 ± 2.512	TREAD MILL
TC/HDL	-0.065 ± 0.271	0.616 ± 0.2460	0.5884 ± 0.203	TREAD MILL
LDL/HDL	-0.057 ± 0.253	0.512 ± 0.289	0.487± 0.1819	TREAD MILL

The difference in mean value between the pre and post tests of tread mill and cycle group was compared, to infer which instrument is best in improvement of lipid profile favourably.

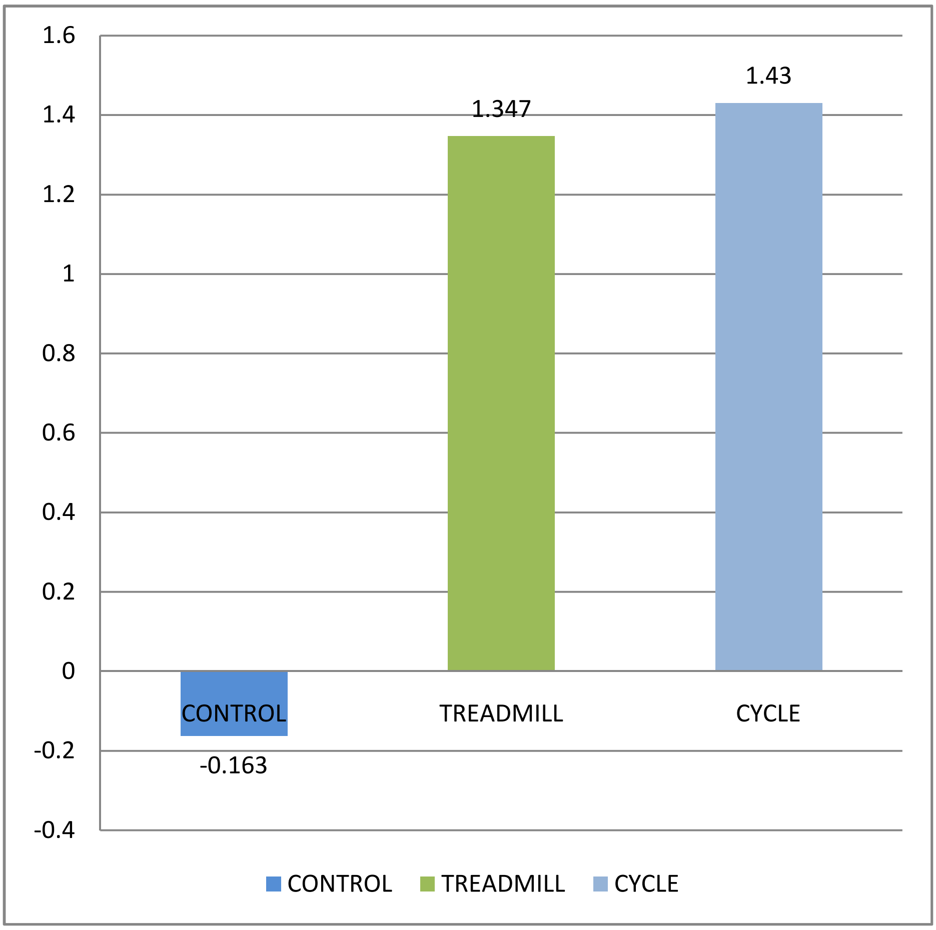
Weight showed the difference in mean ± SD between the pre and post tests of -0.400 ± 1.296; 3.700 ± 2.617 ; 3.600 ± 2.1619 for control, tread mill, and cycle group respectively, which shows there is more reduction of weight in the **tread mill group** compared to cycle group and in control group there is no reduction.(Fig. no: 46) (Table no: 6)

WEIGHT COMPARISON (Fig. 46)



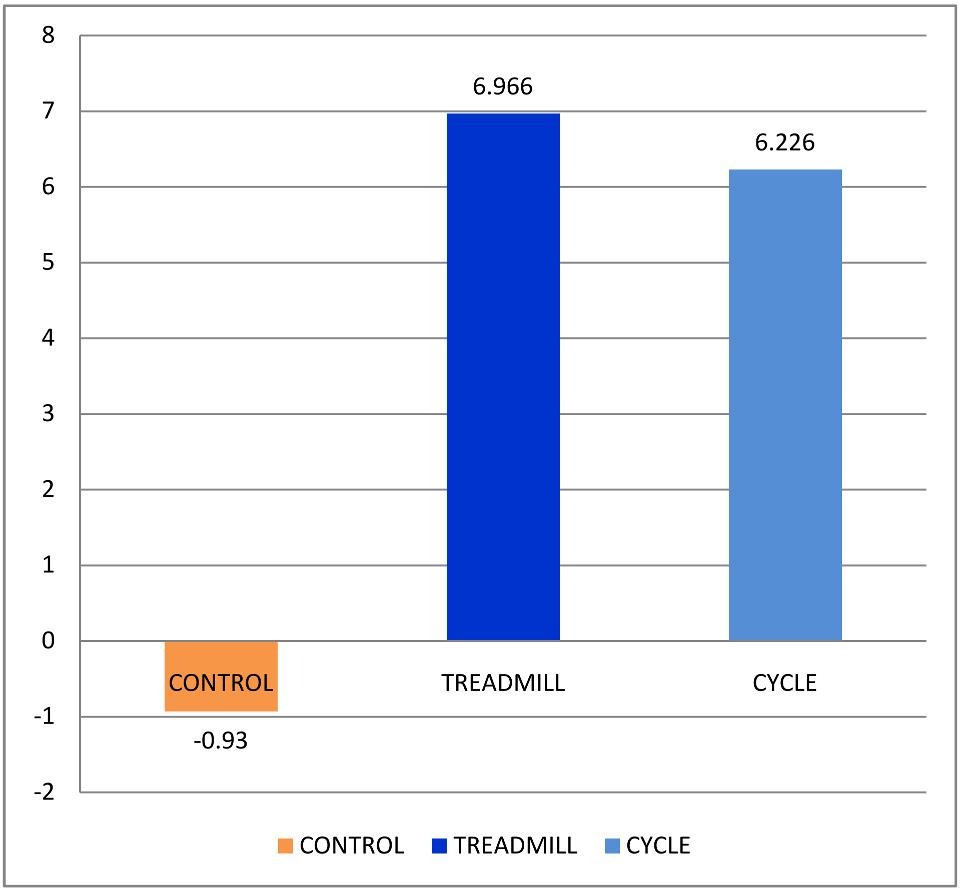
Body Mass Index showed the difference in mean ± SD between pre and post tests of -0.163 ± 0.520; 1.347 ± 0.747; 1.430 ± 0.975 for control, tread mill, and cycle group respectively, which shows there is more reduction of BMI in **cycle group** compared to tread mill group, in control group there is no reduction.(Fig. no: 47) (Table no: 6)

BMI COMPARISON (Fig. 47)



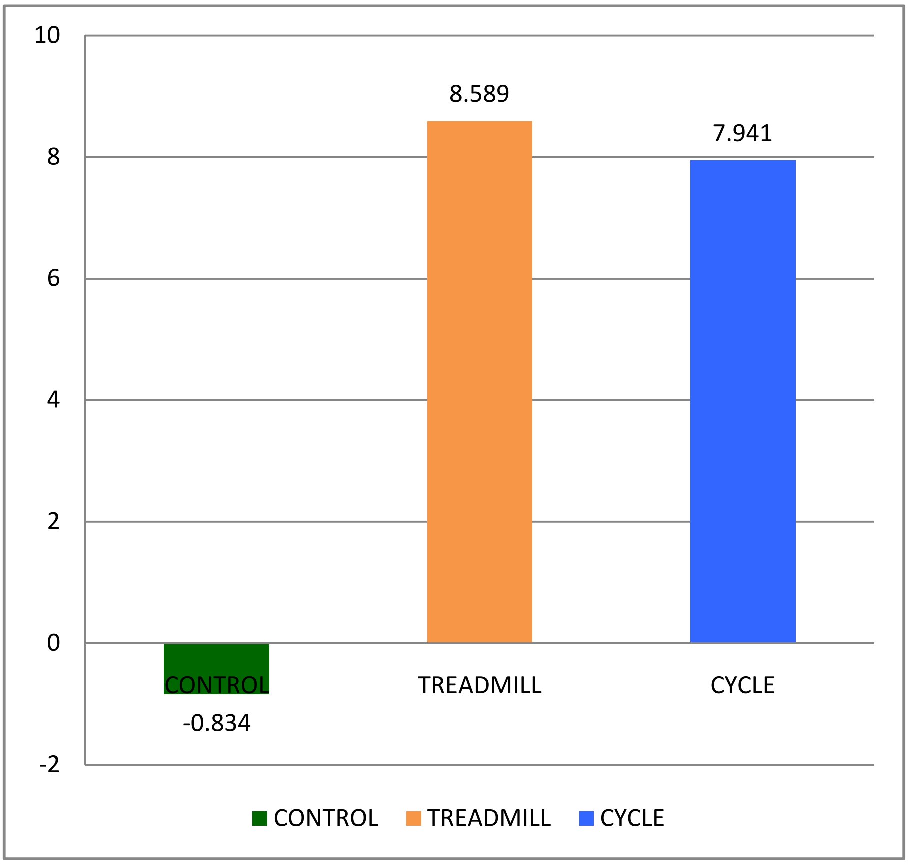
Total Cholesterol, difference between pre and post tests mean ± SD for control group showed -0.930 ± 5.679; treadmill group showed 6.966 ± 1.820; cycle group showed 6.22 ± 1.785; On comparing differences between the means, **treadmill** group had more reduction of total cholesterol compared to cycle group, while in control group there was no improvement. (Fig. no: 48) (Table no: 6)

TOTAL CHOLESTEROL COMPARISON (Fig. 48)



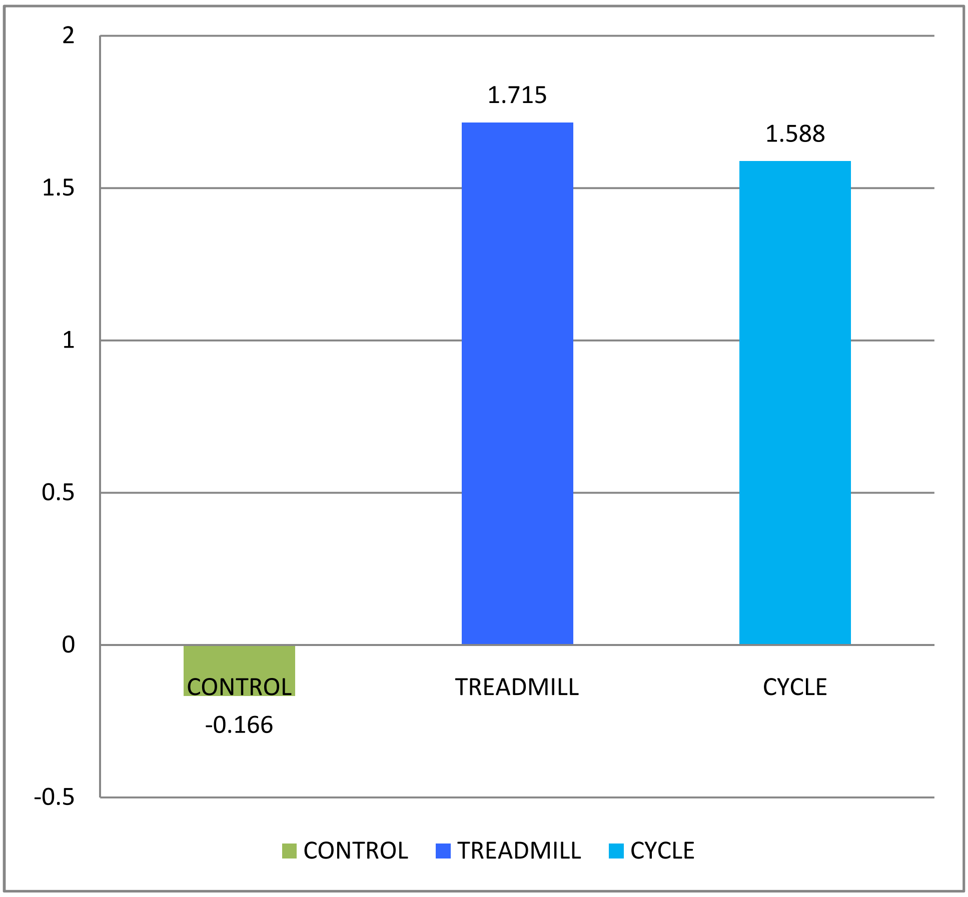
Triglycerides, difference between pre and post tests mean ± SD for control group showed -0.834 ± 7.341; treadmill group showed 8.589 ± 11.596; cycle group showed 7.941 ± 2.758. On comparing differences between the means, **treadmill** group had more reduction of triglyceride compared to cycle group, while in control group there was no improvement. (Fig. no: 49) (Table no: 6)

TRIGLYCERIDES COMPARISON (Fig. no: 49)



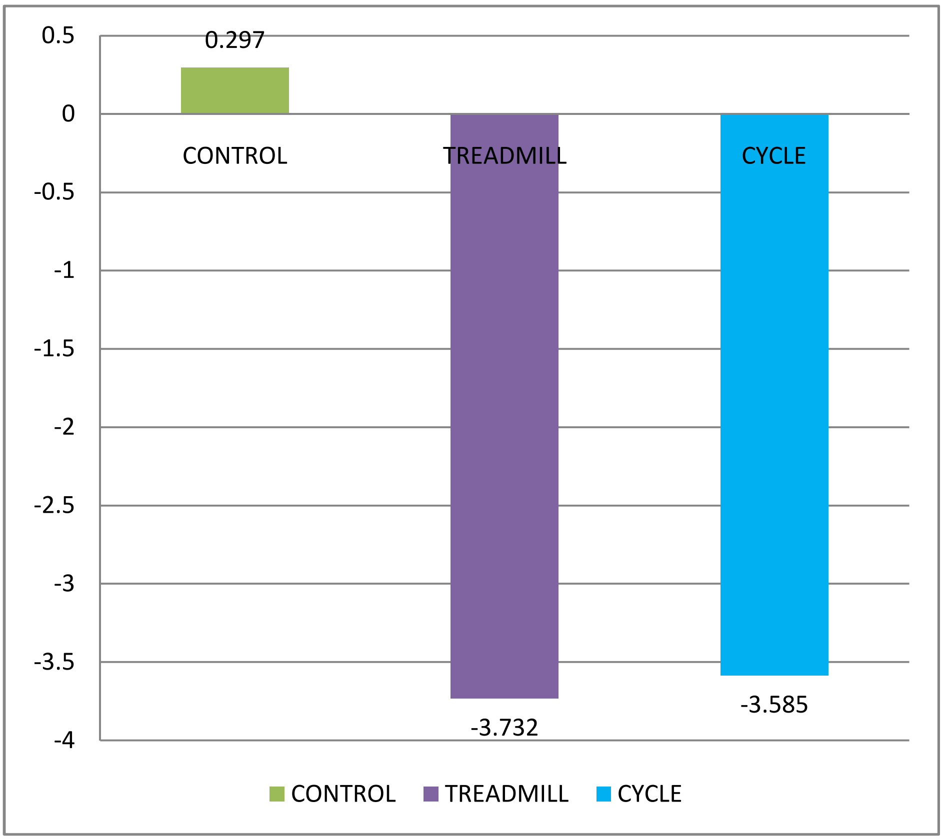
Very Low Density Lipoprotein, difference between pre and post tests mean ± SD for control group showed -0.166 ± 1.468; treadmill group showed 1.715 ± 1.130; cycle group showed 1.588 ± 0.551; On comparing differences between the means, **treadmill** group had more reduction of the very low density lipoprotein compared to cycle group, while in control group there was no improvement.(Fig. no: 50) (Table no: 6)

VERY LOW DENSITY LIPOPROTEIN COMPARISON (Fig. no: 50)



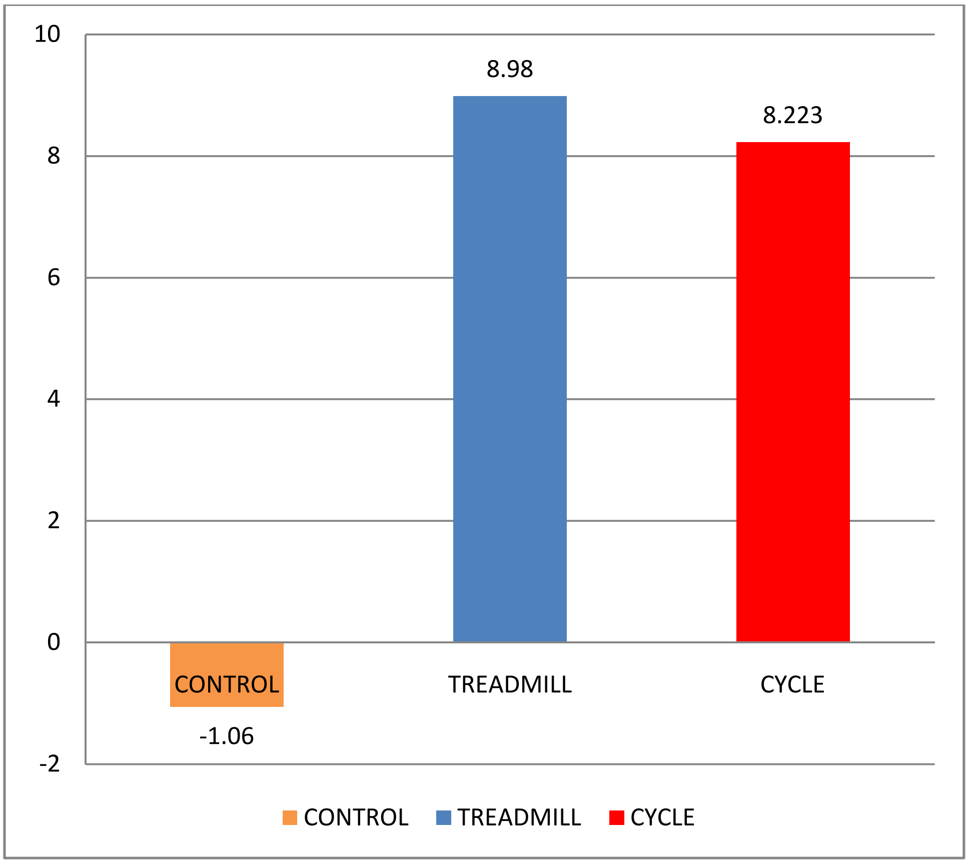
High density lipoprotein, difference between pre and post tests Mean ± SD for control group showed 0.297 ± 1.235; treadmill group showed -3.732 ± 1.886; Cycle group showed -3.585 ± 1.365; On comparing differences between the means, **treadmill** group had more elevation of the high density lipoprotein compared to cycle group, while in control group there was no improvement. (Fig. no: 51) (Table no: 6)

HIGH DENSITY LIPOPROTEIN COMPARISON (Fig. no: 51)



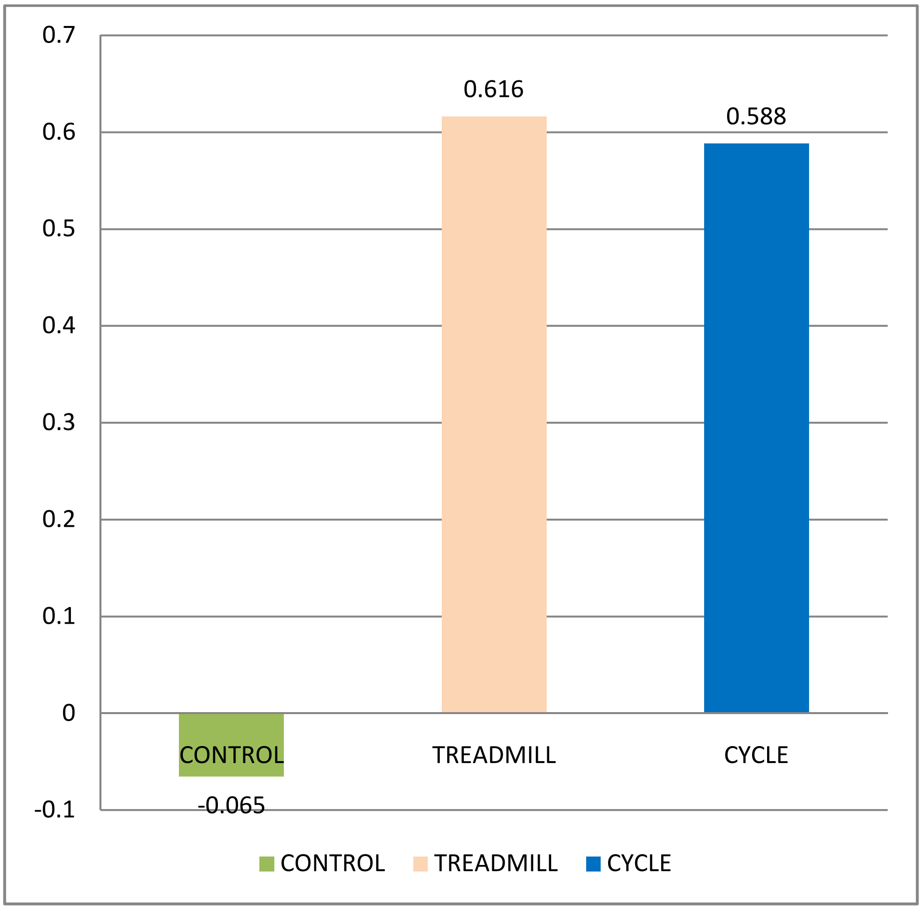
Low density Lipoprotein, difference between pre and post tests mean ± SD for control group showed -1.060 ± 6.571; treadmill group showed 8.980 ± 3.230; cycle group showed 8.223 ± 2.512; On comparing differences between the means, **treadmill** group had more reduction of the low density lipoprotein compared to cycle group, while in control group there was no improvement. (Fig. no: 52) (Table no: 6)

LOW DENSITY LIPOPROTEIN COMPARISON (Fig. no: 52)



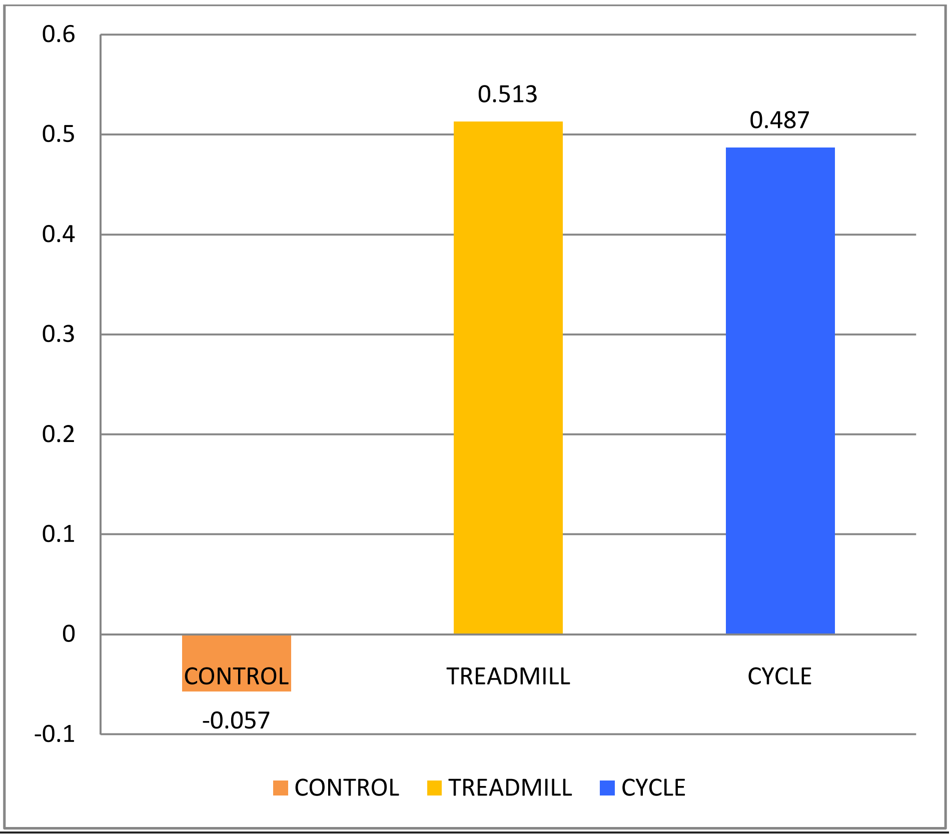
Total Cholesterol and High Density Cholesterol ratio, difference between pre and posts test mean ± SD for control group showed -0.065 ± 0.271; treadmill group showed 0.616 ± 0.2460; cycle group showed 0.588 ± 0.203, On comparing differences between the means, **treadmill** group showed more reduction of the total cholesterol/high density cholesterol ratio compared to cycle group, while in control group there was no improvement. (Fig. no: 53) (Table no: 6)

TC / HDL COMPARISON (Fig. no: 53)



Low Density Lipoprotein and High Density Lipoprotein ratio, difference between pre and post tests mean ± SD for control group showed -0.057 ± 0.253; treadmill group showed 0.512 ± 0.289; cycle group showed 0.487 ± 0.181; On comparing difference between these means, t**readmill** group showed more reduction of the low density lipoprotein and high density cholesterol ratio compared to cycle group, while in control group there was no improvement. (Fig. no: 54) (Table no: 6)

LDL / HDL COMPARISON (Fig. no: 54)



DISCUSSION

DISCUSSION

This study assessed the effects of twelve weeks moderate intensity aerobic training in **tread mill** and **ergometer cycling** on lipid profile and also compared tread mill and ergometer cycle to identify the better instrument favouring the lipid profile.

Earlier investigators studied the effects of aerobic training on these modes, Kenneth R studied the effects on Cardiovascular responses [(45)], Millet GP studied the physiological differences between the two [(65)], and Thomas TR Feiock CW studied the metabolic responses like HR max, VO_2, total energy expenditure, fat energy expenditure, and respiratory exchange ratio [(26)]. Helen carter Andrew studied the physiological effects on oxygen uptake [(66)]. We studied the effects of aerobic training in treadmill and ergometer cycle on lipid profile (TC, TGL, VLDL, LDL, HDL, TD/HDL ratio, and LDL/ HDL ratio)

CA millesis[(67),] Savage MP[(68)], Suter E[(69),] Wood PD et al[(70)], were studied the effects of aerobic exercise on lipid profile (TC, TGL, LDL) and showed significant improvement in these parameters. Similar results were observed in our present study.

Hutten J.K. et al[(71)], Park DH Ransone JW[(72)], and Thompson et al[(73)] studied the effects of aerobic exercise on high density lipoprotein and showed favourable result of increased high density lipoprotein. Similar results were found in our study.

Raz I Israeli A, et al[(74)];Juneau M Rogers F[(75)]; La Rosa JC cleary P et al[(76)]; Lira F yamashita A, et al[(77)] showed the effects of aerobic training and lipid profile for 12 weeks. Results showed significant improvement in BMI, elevation of HDL, lowering of LDL, TC, and TGL. Similar results were observed in our study.

Hellenius ML[(78)],Nieman DC Brock[(79)] studied the effects of aerobic exercise with diet restriction, results showed there was significant favourable effect on lipid profile.

Our study group were not advised of any dietary modification. In spite of no caloric restriction, our results showed highly significant reduction in weight and BMI both in tread mill and cycle group, between pre and post tests of each group. On comparing mean values, it favours the treadmill group for weight, and cycle group for BMI, whereas in the control group no such variation was seen and it infers that tread mill group performed better than the cycle group in weight reduction and cycle group performed better than the treadmill group in BMI reduction.

Klein Jeffrey et al [(80)] and Sopko G et al [(81)] studied the effects of exercise and weight loss on plasma lipids in obese men. Results showed that there was significant reduction in body weight along with improvement in lipid profile. Similar results were found in our study

Al Toriola[(82)], Joseph LJ Dave[(83)]studied the effect of body fat and serum lipids for 12 weeks and showed significant favourable outcome on body composition. These results were consistent with our present study and showed highly significant results pre and post tests of treadmill and cycle group.

Tudor-Locke C Bassett DR[(58)] studied effects of aerobic exercise at moderate intensity for 5 days in a week protocol and showed favourable results. Similar results were observed in our study.

Short term exercise training by Branth S et al'[(84)]and Yalin S et al'[(85)]; Martin BS et al [(86)] studied 24 weeks training showing significant favourable effects on lipid profile (elevation of HDL, lowering of TC,TGL, LDL). In our study we provided 12 weeks of training, similar results were found in our study.

Raurammа R et al' studied the effects on low intensity training[87], Ready EA [88] studied effects on high intensity training; Wooten JS, studied the effects on single bout of exercise on lipoprotein [89] and Pronk N [90],Faidon Magkos [57],Greebe Bom Martin SE [91], studied the effects on acute exercise on lipid profile; Tsetonis NV et al used both type of intensities low and moderate in treadmill [92] These results were consistent with our study (though we provided moderate intensity training).

Thomas TR A. S et al' used four modes showing the effect on fat and metabolic responses on four different modes of training. Their results showed treadmill and skiing group had more energy expenditure and fat utilization. [26] These results are in accordance with our present study. Blanca romero et al, studied the effects of the different modes on aerobic exercise, showing no significant difference between different modes. [44] Similarly our study showed no difference between treadmill group and ergometer cycle group on comparing pre test and post test results.

Hag berb JM, described the effects of pedalling rate in moderate exercise [93]; Kang J, 2005 studied the metabolic responses to cycling. [94] These results are consistent with our present study.

Millet GP[65] studied the physiological differences between cycle and treadmill, Thomas TR Feiock CW [26] studied the metabolic responses like heart rate maximum,VO_2, total energy expenditure, fat energy expenditure, respiratory exchange ratio and Helan Carter Andrew studied the physiological effects of oxygen uptake [66] comparison was done between treadmill and cycle group. King AB studied the effects of lipid profile on home based training [95] All these studies **favoured tread mill** as high energy expenditure instrument compared to cycle. Similar results were found in our study.

Baker TT observed the effects of aerobic exercise on middle aged individuals;[96]. Similar results were observed in our study

Wosornue et al studied [63] the effect of resistance and endurance training after coronary artery bypass graft surgery. In their study, exercise alone did not show any improvement in post operative bypass graft patients. Allison TG [97] studied the effects of HDL on aerobic exercise which showed no significant elevation after exercise, The results of these two studies are in contrast to our present study.

In our study we observed, there was significant difference between pre (before starting exercise) and post tests (after the aerobic exercise intervention for 12 week 5 days per week) of moderate intensity. We observed a favourable change in anthropometric measurements, a favourable change in lipid profile (lowering of TC, TGL, VLDL, LDL, TC/HDL ratio, LDL/HDL ratio, and elevation of HDL). The study results are encouraging for both treadmill and cycle groups which show significant improvement in post test results compared to pre test results (baseline). Treadmill group, cycle group, and aerobic exercise group (treadmill and cycle combined) showed highly significant favourable improvement in post test results compared to pre test values, whereas the control (sedentary) group showed no significant change (no improvement) in post test results compared to pre test results. There is a difference in the mean, between **treadmill group** (pre and post tests mean difference) and **cycle group** (pre and post tests mean difference) for TC, TGL, VLDL, LDL, TC/HDL ratio and LDL/HDL ratio which were reduced and HDL was elevated, **favouring** the **treadmill group**, due to **more energy expenditure**. As the mean value is a powerful and sensitive indicator, we conclude that the **treadmill is better** than the ergometer cycle in aerobic exercise related to lipid profile. Anne I. Zeni [21] studied the effects on indoor exercise machines, on energy expenditure which showed slight improvement in tread mill group compared to the cycle group. This is because of more energy expenditure. Similar results were observed in our study.

Comparing the treadmill and bicycle, advantages and disadvantages are seen in both. Tread mill is readily accepted by the individual as it simulates natural walking. Ergometer cycle is economical occupies less space and needs no electricity, compared to treadmill [(29)]. The disadvantage in the cycle is that, lower limb muscles (quadriceps and hamstring muscle) fatigue is readily seen which limit work performed but this is not so in the tread mill. The disadvantage of treadmill in the long run is that since it is a weight bearing exercise, it strains and stresses the weight bearing joints (specially hips and knees) and over a period of time, there are chances for premature degenerative arthritis in these joints, but in contrast, the cycle is a non-weight bearing work out, as it does not strain the joints [(29)]. Advantage of cycling is that there is no risk of fall, whereas in treadmill there is a chance of falling and injury.

In terms of energy expenditure, tread mill is ideal, as it exercises the core muscles of the body like abdominal, back and upper limbs (due to swinging of arms) and is the reason for more calorie burning on the treadmill than ergometer cycle [(21,41,42,43)]. In cycling, individuals may fatigue easily and the energy expenditure is based on the pedalling cadence which is under the control of subject themselves and not on the observers part (in contrast tread mill where speed is under the control of observer, observer sets the speed) and this may be a contributing factor for more energy expenditure in tread mill group compared to the cycle group. The choice of instrument (treadmill or ergometer) depends on the weight, body mass index, and age of the individual. If the patient is young with no pre existing risks factor like obesity and joint arthritis, tread mill is preferable, in old and obese patient the cycle is preferred.

CONCLUSION

CONCLUSION

The study results revealed that aerobic exercise has a definite favourable impact on lipid profile, compared to sedentary individuals. In general, the physiological responses of these exercise modes (treadmill and ergometer cycle) are almost similar. Both the instruments favour lipid profile. But treadmill group showed higher energy expenditure and more favourable results (elevation of HDL and lowering of TC, TGL, VLDL, LDL, TC/HDL, LDL/HDL) than cycle group. Those differences which were observed are small; thus both treadmill and bicycle ergometer can be recommended for the favourable improvement of the lipid profile. The choice of instruments is individualized. If an obese or older individual is to be subjected to aerobic training, cycle is the better choice compared to treadmill. If the patient is young with no pre existing risks factor like obesity and joint arthritis, tread mill is preferable. This study was done only in young healthy volunteers. Whereas in older patients with systemic diseases like diabetes, hypertension, etc., usually associated with lipid abnormalities, they are more prone to develop cardio vascular disease; hence older individuals should be targeted in future studies. In old individuals, change in lipid profile is not so quick as in younger. In future studies other metabolic parameters like heart rate maximum, VO_2 max, and lactate threshold (to prove exercise is purely aerobic) can be included.

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ANNEXURE

ABBREVIATIONS USED IN THE STUDY

BMI - Body Mass Index

BP - Blood Pressure

HDL - High Density Lipoprotein

LDL - Low Density Lipoprotein

VLDL - Very Low Density Lipoprotein

TC - Total Cholesterol

TGL - Triglycerides

CAD - Coronary Artery Disease

CHD - Coronary Heart Disease

CVD – Cardio Vascular Disease

RPM - Revolutions Per Minute

METs - Metabolic Energy Expenditure

SD - Standard Deviation

AHA- American Heart Association

ACSM - American college of Sports Medicine

WHO - World Health Organization

PROFORMA

Topic: Effects of Aerobic Training on Lipid profile)

Study group/Control group

Name: Age: Sex:

Address: Occupation:

Phone no:

Present history: Known HT/DM/Asthma/Renal disease/liver disease

H/o involving any other routine exercise activity

Past history: H/o limitation to Activity in any form/ Dyslipedemia

Personal history: Smoking/alcohol/betal nut chewing with or without tobacco

Menstrual history:

(in case of female)

General Examination/Vital Signs:

Height: Weight BMI:

Anemic / Not anemic

Cyanosis / No cyanosis

Clubbing / No Clubbing

Jaundice / Not jaundiced

Pedal edema / No pedal edema

Generalised lympadenopathy present/Absent

Vital Signs: PR: BP: RR:

Examination of CVS:

Examination of RS:

Examination of Abdomen:

Examination of CNS:

Investigations:

LIPID PROFILE (PRE TEST)

Cholesterol	mg/dl
Triglycerides	mg/dl
LDL-cholesterol	mg/dl
VLDL-cholesterol	mg/dl
HDL-cholesterol	mg/dl
Cholesterol/HDL Ratio	
LDL/HDL Ratio	

LIPID PROFILE (POST TEST- AFTER 12 WEEKS)

Cholesterol	mg/dl
Triglycerides	mg/dl
LDL-cholesterol	mg/dl
VLDL-cholesterol	mg/dl
HDL-cholesterol	mg/dl
Cholesterol/HDL Ratio	
LDL/HDL Ratio	

INFORMED CONSENT FORM

Dr. M. Sathish, Post graduate student in the Department of physiology, Thanjavur Medical college, Thanjavur is studying the "**Effects of Aerobic Training on Lipid profile"**

I understand the procedure and voluntarily agree to participate in the study, I also understand that this study is a non-invasive procedure and the possible adverse effects have been explained to me in details clearly in my own language.

Signature of the subject

Name:

Place:

Date:

MASTER CHART

MASTER CHART																						
				PRE TEST										POST TEST								
S. NO	GROUP	AGE	SEX	HEIGHT	WEIGHT	BMI	TC	TGL	VLDL	HDL	LDL	TC/HD	LDL/HDL	WEIGHT	BMI	TC	TGL	VLDL	HDL	LDL	TC/HDL	LDL/HDL
1	A	28	F	1.53	52	22.21	180.66	160.75	32.15	44.52	103.99	4.057	2.335	51	21.78	182.72	158.52	31.704	42.2	108.816	4.329	2.578
2	A	27	F	1.52	64	27.70	162.55	144.46	28.892	32.85	100.808	4.948	3.068	66	28.56	175.58	145.37	29.074	31.56	114.946	5.563	3.642
3	A	35	F	1.62	66	25.14	204.91	170.11	34.022	34.29	136.598	5.975	3.983	64	24.38	206.58	175.54	35.108	35.1	136.372	5.885	3.885
4	A	25	M	1.82	69	20.83	156.55	130.54	26.108	35.57	94.872	4.401	2.667	70	21.13	158.54	136.35	27.27	36.47	94.8	4.347	2.599
5	A	35	F	1.55	64	26.63	192.1	102.42	20.484	40.56	131.056	4.736	3.231	65	27.05	195.35	104.56	20.912	38.56	135.878	5.066	3.523
6	A	33	M	1.78	81	25.56	181.75	102.23	20.446	34.75	126.554	5.230	3.641	81	25.56	185.45	109.21	21.842	32.86	130.748	5.643	3.978
7	A	26	M	1.64	52	19.33	195.47	169.97	33.994	30.79	130.686	6.348	4.244	52	19.33	189.32	162.45	32.49	31.58	125.25	5.994	3.966
8	A	25	M	1.64	65	24.16	189.3	109.56	21.912	32.58	134.808	5.810	4.137	65	24.16	190.56	111.35	22.27	31.56	136.73	6.038	4.332
9	A	29	M	1.61	64	24.69	166.81	129.77	25.954	35.96	104.896	4.638	2.917	67	25.84	164.65	120.54	24.108	36.45	104.092	4.517	2.855
10	A	29	F	1.57	64	25.96	170.49	109.2	21.84	35.96	112.69	4.741	3.133	66	26.77	174.65	102.56	20.512	36.52	117.618	4.782	3.220
11	A	29	M	1.66	85	30.84	175.45	156.35	31.27	40.56	103.62	4.32	2.554	84	30.48	172.56	169.5	33.9	41.25	97.41	4.183	2.361
12	A	30	F	1.76	83	26.79	210.37	128.56	25.712	40.55	144.108	5.187	3.553	83	26.79	205.56	132.65	26.53	38.86	140.17	5.289	3.607
13	A	32	M	1.68	65	23.03	169.62	143.32	28.664	37.51	103.446	4.521	2.757	65	23.03	176.89	139.65	27.93	35.24	113.72	5.019	3.227
14	A	29	F	1.59	65	25.71	205.67	98.53	19.706	38.81	147.154	5.299	3.791	66	26.10	196.53	96.45	19.29	39.1	138.14	5.026	3.532
15	A	33	F	1.59	65	25.71	174.65	89.95	17.99	40.1	116.56	4.355	2.906	64	25.31	172.12	98.66	19.732	41.11	111.278	4.186	2.706
16	A	29	F	1.54	61	25.72	191.73	106.23	21.246	29.45	141.034	6.510	4.788	65	27.40	195.48	108.65	21.73	29.1	144.65	6.717	4.970
17	A	26	M	1.68	77	27.28	210.41	118.52	23.704	41.89	144.816	5.022	3.457	77	27.28	213.56	116.82	23.364	38.45	151.746	5.554	3.946
18	A	35	F	1.56	71	29.17	197.71	118.41	23.682	43.56	130.468	4.538	2.995	73	29.99	189.42	110.58	22.116	44.89	122.414	4.219	2.726
19	A	30	M	1.71	72	24.62	155.62	156.74	31.348	36.56	87.712	4.256	2.399	73	24.96	159.57	146.84	29.368	35.78	94.422	4.459	2.638
20	A	34	F	1.68	68	24.09	172.61	108.53	21.706	29.71	121.194	5.809	4.079	69	24.44	182.65	110.36	22.072	29.1	131.478	6.276	4.518
21	A	33	M	1.57	85	34.48	205.11	136.34	27.268	32.12	145.722	6.385	4.536	86	34.88	196.15	138.45	27.69	33.59	134.87	5.839	4.015
22	A	31	F	1.68	65	23.03	177.15	148.36	29.672	36.71	110.768	4.825	3.017	66	23.38	184.36	150.42	30.084	35.46	118.816	5.199	3.350
23	A	35	F	1.54	75	31.62	158.39	101.26	20.252	40.83	97.308	3.879	2.383	74	31.20	168.55	110.45	22.09	39.36	107.1	4.282	2.721
24	A	29	F	1.69	84	29.41	203.62	180.74	36.148	35.97	131.502	5.660	3.655	83	29.06	207.64	176.25	35.25	36.41	135.98	5.702	3.734

25	A	25	M	1.52	55	23.80	189.67	160.71	32.142	35.86	121.668	5.28	3.392	55	23.80	191.54	158.35	31.67	36.45	123.42	5.254	3.386
26	A	35	M	1.61	67	25.84	181.67	152.84	30.568	41.83	109.272	4.343	2.612	67	25.84	179.98	155.58	31.116	40.12	108.744	4.486	2.710
27	A	35	F	1.63	68	25.59	186.64	134.74	26.948	38.65	121.042	4.828	3.131	66	24.84	184.49	136.58	27.316	39.54	117.634	4.665	2.975
28	A	35	M	1.7	70	24.22	196.72	169.43	33.886	32.18	130.654	6.113	4.060	71	24.56	195.23	160.51	32.102	33.14	129.988	5.891	3.922
29	A	25	M	1.59	67	26.50	181.63	126.54	25.308	42.35	113.972	4.288	2.691	68	26.89	178.64	130.68	26.136	40.58	111.924	4.402	2.758
30	A	35	M	1.62	67	25.52	198.62	163.54	32.708	35.47	130.442	5.599	3.677	69	26.29	209.54	160.77	32.154	36.45	140.936	5.748	3.866
31	A	30	F	1.56	75	30.81	210.53	105.66	21.132	42.43	146.968	4.961	3.463	74	30.40	199.95	129.89	25.978	43.14	130.832	4.634	3.032
32	A	29	M	1.59	59	23.22	187.62	140.96	28.192	32.75	126.678	5.728	3.868	59	23.33	192.45	150.55	30.11	32	130.34	6.014	4.073
33	A	25	F	1.62	73	27.81	146.59	134.87	26.974	35.87	83.746	4.086	2.334	73	27.81	150.23	129.45	25.89	36.41	87.93	4.126	2.414
34	A	35	M	1.47	53	24.52	185.93	125.47	25.094	36.97	123.866	5.029	3.320	55	25.45	180.64	135.96	27.192	37.05	116.398	4.875	3.141
35	A	34	M	1.66	80	29.03	202.88	139.65	27.93	43.76	131.19	4.636	2.997	81	29.39	197.67	130.54	26.108	44.01	127.552	4.491	2.898
36	A	33	M	1.6	79	30.85	210.11	133.36	26.672	34.79	148.648	6.039	4.272	80	31.25	208.54	130.85	26.17	35.1	147.27	5.941	4.195
37	A	34	M	1.61	70	27.00	209.54	130.75	26.15	40.87	142.52	5.126	3.487	69	26.61	214.64	120.48	24.096	41.54	149.004	5.167	3.587
38	A	34	M	1.6	74	28.90	160.58	122.73	24.546	42.15	93.884	3.809	2.227	73	28.51	161.58	120.58	24.116	40.57	96.894	3.982	2.388
39	A	32	F	1.66	73	26.49	165.48	128.54	25.708	38.93	100.842	4.250	2.590	73	26.49	169.39	130.74	26.148	38.1	105.142	4.445	2.759
40	A	30	M	1.57	70	28.39	158.47	116.64	23.328	33.74	101.402	4.696	3.005	70	28.39	159.64	126.98	25.396	34.1	100.144	4.681	2.936
41	B	27	M	1.64	67	24.91	173.82	108.47	21.694	42	110.126	4.138	2.622	65	24.16	166.24	100.28	20.056	45.54	100.644	3.650	2.210
42	B	25	F	1.55	62	25.80	189.72	114.02	22.804	45.4	121.516	4.178	2.676	56	23.30	182.32	106.97	21.394	49.41	111.516	3.689	2.256
43	B	29	M	1.66	69	25.03	187.41	135.31	27.062	45.28	115.068	4.138	2.541	65	23.58	180.3	128.25	25.65	49.63	105.02	3.632	2.116
44	B	25	F	1.48	44	20.08	210.56	139.76	27.952	33.17	149.438	6.347	4.505	42	19.17	203.31	132.75	26.55	35.3	141.46	5.759	4.007
45	B	28	M	1.74	59	19.48	164.64	121.85	24.37	34.01	106.26	4.840	3.124	58	19.15	160.51	117.42	23.484	36.28	100.746	4.424	2.776
46	B	32	M	1.65	71	26.07	177.2	128.76	25.752	30.58	120.868	5.794	3.952	69	25.34	167.63	114.7	22.94	36.52	108.17	4.590	2.961
47	B	25	M	1.71	78	26.67	160.29	137.23	27.446	42.76	90.084	3.748	2.106	74	25.30	155.5	109.6	21.92	46.2	87.38	3.365	1.891
48	B	33	F	1.46	66	30.96	211.17	116.2	23.24	32.41	155.52	6.515	4.798	63	29.55	207.52	111.75	22.35	35.8	149.37	5.796	4.172
49	B	35	M	1.62	60	22.86	221.1	136.1	27.22	35.8	158.08	6.175	4.415	56	21.33	214.64	130.5	26.1	39.76	148.78	5.398	3.741
50	B	26	F	1.5	69	30.66	171.03	108.44	21.688	37.84	111.502	4.519	2.946	65	28.88	162.46	96.45	19.29	40.44	102.73	4.017	2.540
51	B	35	M	1.61	80	30.86	184.8	143.6	28.72	41.07	115.01	4.499	2.800	75	28.93	174.48	140.68	28.136	48.2	98.144	3.619	2.036
52	B	25	M	1.66	64	23.22	210.8	165.1	33.02	37.18	140.6	5.669	3.781	62	22.49	204.47	161.85	32.37	39.8	132.3	5.137	3.324

53	B	30	M	1.67	86	30.83	161	124.39	24.878	36.03	100.092	4.468	2.778	81	29.04	156.67	117.78	23.556	40.58	92.534	3.860	2.280
54	B	29	F	1.66	109	39.55	219.27	158.3	31.66	35.9	151.71	6.107	4.225	96	34.83	214.03	152.61	30.522	39.62	143.888	5.402	3.631
55	B	27	F	1.5	63	28	180.09	135.24	27.048	38.84	114.202	4.636	2.940	59	26.22	173.05	130.47	26.094	40.21	106.746	4.303	2.654
56	B	32	M	1.57	65	26.37	160.34	109.99	21.998	34.16	104.182	4.693	3.049	60	24.34	152.31	100.5	20.1	43.3	88.91	3.517	2.053
57	B	35	F	1.59	62	24.52	206.1	130.25	26.05	36.25	143.8	5.685	3.966	60	23.73	199.26	121.23	24.246	39.64	135.374	5.026	3.415
58	B	31	M	1.69	65	22.75	148.65	108.86	21.722	35.57	91.308	4.179	2.566	63	22.05	140.73	100.4	20.08	38.84	81.81	3.623	2.106
59	B	35	M	1.7	74	25.60	168.43	133.99	26.798	35.93	105.702	4.687	2.941	71	24.56	159.26	126.4	25.28	38.45	95.53	4.142	2.484
60	B	25	F	1.65	45	16.52	178.84	110.81	22.162	46.84	109.838	3.818	2.344	44	16.16	171.25	94.3	18.86	48.14	104.25	3.557	2.165
61	C	28	F	1.53	60	25.63	184.28	138.03	27.606	41.11	115.564	4.482	2.811	58	24.77	177.54	130.53	26.106	45.99	105.444	3.860	2.292
62	C	35	F	1.55	85	35.37	193.79	120.56	24.112	36.75	132.928	5.273	3.617	80	33.29	188.42	113.85	22.77	39.54	126.11	4.765	3.189
63	C	34	M	1.72	70	23.38	175.18	117.56	23.512	30.45	121.218	5.753	3.980	68	22.98	168.22	109.96	21.992	33.56	112.668	5.012	3.357
64	C	33	M	1.65	80	29.38	190.67	109.2	21.84	34.56	134.27	5.517	3.885	75	27.54	183.44	101.67	20.334	41.21	121.896	4.451	2.957
65	C	35	M	1.58	58	23.23	192.43	119.73	23.946	40.01	128.474	4.809	3.211	55	22.03	188.1	111.56	22.312	44.48	121.308	4.228	2.727
66	C	35	M	1.75	102	33.30	216.01	146.77	29.354	35.28	151.376	6.122	4.290	96	31.34	209.01	141.58	28.316	40.49	140.204	5.162	3.462
67	C	29	M	1.47	62	28.69	144.21	127.5	25.5	34.7	84.01	4.155	2.421	59	27.30	140.54	120.44	24.088	36.2	80.252	3.882	2.216
68	C	25	M	1.69	74	25.90	166.58	149.18	29.836	35.67	101.074	4.670	2.833	66	23.10	162.7	139.5	27.9	40.9	93.9	3.977	2.295
69	C	28	M	1.73	105	35.08	154.27	156.24	31.248	44.67	78.352	3.453	1.754	96	32.07	149.3	145.52	29.104	48.37	71.826	3.086	1.484
70	C	27	F	1.59	61	24.12	184.65	124.34	24.868	38.36	121.422	4.813	3.165	60	23.73	179.45	115.56	23.112	42.54	113.798	4.218	2.675
71	C	28	F	1.53	60	25.63	207.6	136.85	27.37	38.5	141.73	5.392	3.681	57	24.34	197.84	129.65	25.93	42.37	129.54	4.669	3.057
72	C	32	F	1.5	88	39.11	168.9	127.7	25.54	32.9	110.46	5.133	3.357	85	37.77	163.6	115.45	23.09	35.34	105.17	4.629	2.975
73	C	25	M	1.58	65	26.03	166.87	123.58	24.716	38.78	103.374	4.302	2.665	60	24.03	160.33	119.66	23.932	42.87	93.528	3.739	2.181
74	C	27	M	1.68	63	22.32	143.46	112.78	22.556	33.27	87.634	4.311	2.634	60	21.25	139.77	108.15	21.63	36.55	81.59	3.824	2.232
75	C	25	M	1.64	70	26.02	197.6	124.7	24.94	36.7	135.96	5.384	3.704	66	24.58	189.5	110.68	22.136	40.46	126.904	4.683	3.136
76	C	32	M	1.65	56	20.56	194.26	134.42	26.884	36.95	130.426	5.257	3.529	55	20.20	187.4	126.54	25.308	38.46	123.632	4.872	3.214
77	C	35	M	1.6	62	24.21	172.08	119.2	23.84	36.97	111.27	4.654	3.009	59	23.04	167.29	111.2	22.24	38.42	106.63	4.354	2.775
78	C	34	F	1.56	52	21.3	206.45	142.62	28.524	34.78	143.146	5.935	4.115	50	20.54	199.11	130.35	26.07	38.42	134.62	5.182	3.503
79	C	35	F	1.57	57	23.14	166.62	142.6	28.52	34.56	103.54	4.821	2.995	55	22.31	159.36	138.69	27.738	36.74	94.882	4.337	2.582
80	C	26	M	1.71	86	29.40	182.5	125.21	25.042	47.88	109.578	3.811	2.288	84	28.72	172.96	119.4	23.88	51.65	97.43	3.348	1.886